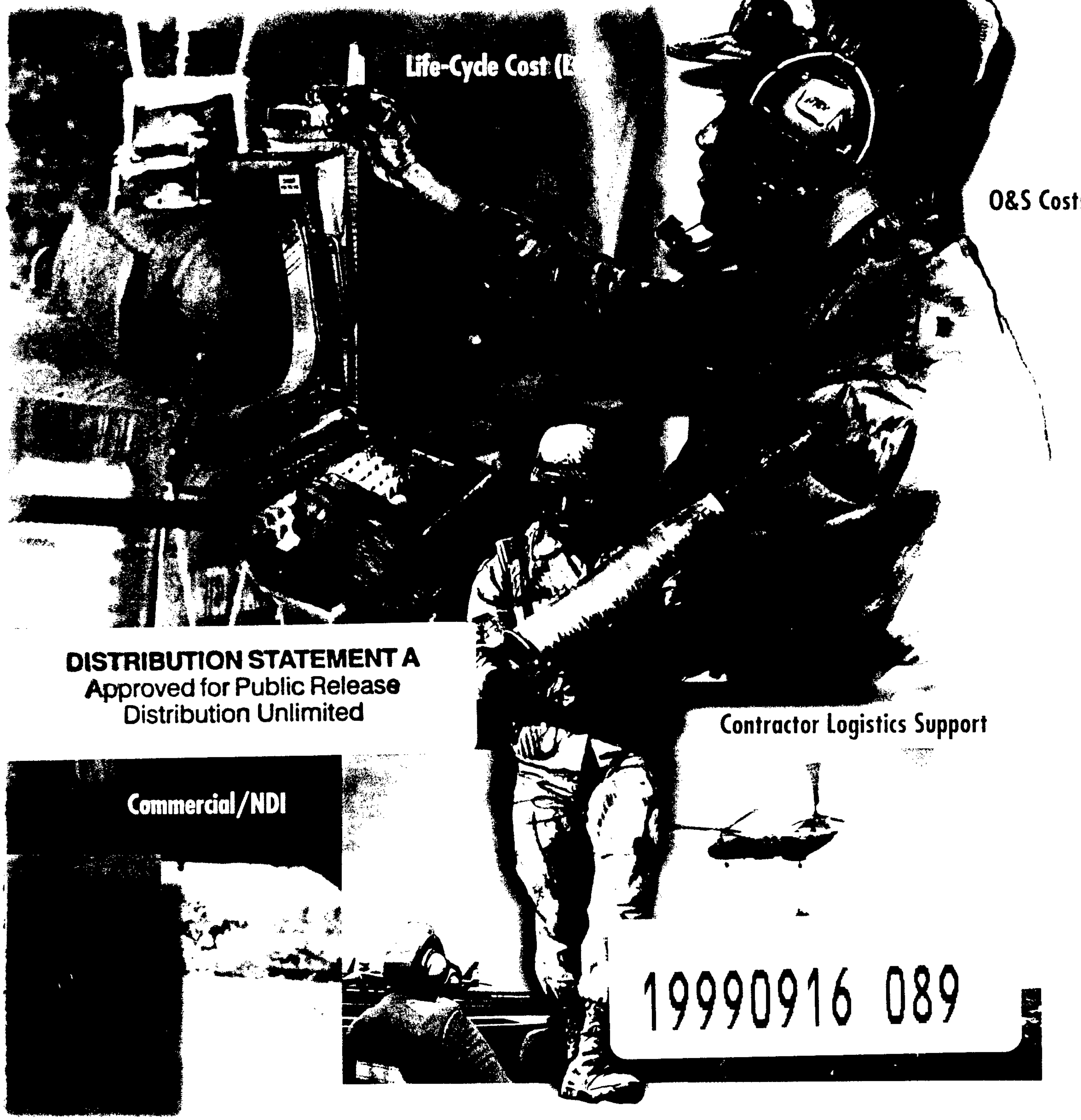
DEFENSE SYSTEMS MANAGEMENT COLLEGE

ACQUISITION LOGISTICS GUIDE

DECEMBER 1997



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ACQUISITION LOGISTICS GUIDE

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THIRD EDITION

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CONTRIBUTING TO THE LOGISTICS FACULTY BODY OF KNOWLEDGE THAT HELPED BRING THIS EDITION TO PRINT:

DSMC LOGISTICS MANAGEMENT FACULTY MEMBERS:
LT COL MARK FANTASIA, USAF, DEPARTMENT CHAIRMAN
CDR STEVE ARTZER, USN
LTC CARL GARDNER, USA
LT COL LARRY HELLER, USAF
MR. JOEL MANARY
MR. PAUL McILVAINE, FORMER TECHNICAL MGMT. DEPT. CHAIRMAN
MR. GEORGE MERCHANT
MR. JOHN RIFFEE

INFORMATION SPECTRUM, INC., EMPLOYEES:
NORMAN BULL
CARLETON COOPER

DSMC LOGISTICS MANAGEMENT DEPARTMENT SUPPORT STAFF:
MS. URSULA LILLIMAN

DSMC VISUAL ARTS AND PRESS DEPARTMENT
MRS. KATHRYN SONDHEIMER, Editing and Desktop Publishing
MRS. DEBRA GONZALEZ, Desktop Publishing

PREFACE TO THE THIRD EDITION

This guide has been prepared as a training aid for use in DSMC courses of instruction. This edition of the DSMC Acquisition Logistics Guide supersedes all previous editions. The changes made in this edition are quite substantial, reflecting the latest Department of Defense (DoD) acquisition policies and procedures as described in the DoDD 5000.1 and DoD 5000.2-R. This guide was originally designed to be one in a family of technical management educational guides written from a DoD perspective, which includes:

Systems Engineering Management Guide
Mission Critical Computer Resources Management Guide
Test and Evaluation Management Guide
Defense Manufacturing Management Guide

We plan to update this document at appropriate intervals, in consonance with DSMC course materials updates. This guide has been organized to facilitate future update through an "open systems" taxonomy. We also plan to provide the latest version of this guide through the DSMC Internet Home Page:

http://www.dsmc.dsm.mil

Suggested additions, deletions, and other improvement suggestions are encouraged from readers of this guide. Send them to:

Department of Defense
Defense Sys Mgmt College
ATTN Logistics Management Department (FD-LM)
9820 Belvoir Road
Suite 3
Fort Belvoir, VA 22060-5565

Phone: 703-805-4658
Fax #: 703-805-3709
e-mail: riffeej@dsmc.dsm.mil

Mark Fantasia
Lt Col, USAF
Chairman
Logistics Management Department

John Riffee
Project Coordinator
Logistics Management Department

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BACKGROUND

"The essential condition for an army to be able to withstand the strain of the battle is an adequate stock of weapons, petrol, and ammunition. In fact, the battle is fought and decided by the quartermaster before the shooting begins. The bravest men can do nothing without guns nor ammunition; and neither guns nor ammunition are of much use in mobile warfare unless there are vehicles with sufficient petrol to haul them around. Maintenance must also approximate in quantity to that available to the enemy."

Field Marshal Erwin Rommel

"...no writer has ever succeeded in glamorizing it. The result is that logistics are usually either downplayed or ignored altogether. But logistics were the lifeblood of the Allied armies in France. Without ports and facilities we could not move, shoot, eat, land new troops or evacuate the wounded."

A General's Life
by Omar N. Bradley

1.1 THE COLD WAR YEARS

In the years following World War II, the United States entered a period of technological competition with the then Soviet Union called the Cold War. It was a classic quality versus quantity confrontation. The Soviets designed and built tough, technically simple, iterative systems that could be produced in large numbers. The United States usually chose the latest technological solution and relied on projected higher "kill ratios" to prevail in combat even if the confrontations were between Soviet and U.S. Third-World clients.

By the middle of the 1960s, a terrible truth was obvious about the U.S. commitment to high technology. Our systems were fragile, expensive to support, and short-lived when employed. The F-111 aircraft was the classic example. Brilliant in concept, it was formidable on the rare occasion when everything worked and lasted for the duration of a mission. The amount of equipment and number of personnel required to support that aircraft and the support costs involved were shocking. A new philosophical approach was definitely required.

The philosophy was simple to state: Influence the design of a system from its conception so that support was considered and life-cycle costs minimized. The implementation was more difficult. The iterative nature of the design and manufacturing process created disciplinary "stovepipes" that resisted the intrusion of support considerations on design, and the logisticians lacked an effective tool-set to credibly present their arguments. Intuition wasn't good enough.

Adapted from Romer, Richard: "The Barbarians at the Gate," *Logistics Spectrum,* Fall 1994.

1.2 THE CHANGING ACQUISITION PROCESS

Over the past 30 years, acquisition professionals have witnessed numerous changes in Department of Defense policy dealing with research and development and the procurement of systems and their support. Early directives emphasized an arms-length relationship with the defense industry, compliance with detailed regulations, cumbersome non-value added processes, and costly oversight/how-to-do-it procedures for the design and manufacture of our sophisticated defense systems. Interim policies stressed multi-layered review processes to reduce risk and cost growth while somehow meeting fixed program schedules. This same period also witnessed phenomenal technological advances in the development of software, computer hardware, electronics, aviation, and missile systems.

From the point of view of the system Program Manager (PM), the management environment was difficult at best and few major programs enjoyed the reputation of meeting initial cost, schedule, and sometimes, performance objectives. Life was not easy for acquisition logisticians either. Although "Concurrent Engineering" (which has some aspects of today's Integrated Product and Process Development) was established in the late 1970's, program office functionals operated as "stove pipe" activities in a loose alliance trying to meet common objectives.

1.3 A NEW WAY OF DOING BUSINESS

However, 1996 was a banner year for acquisition policy changes. Defense policies now included acquisition streamlining, integrated product development, performance specifications, and the non-use of military specifications and standards. Many PMs dedicated many labor hours to implementing these new policies. The 15 March 1996 reissuance of DoDD 5000.1 and DoD 5000.2-R (later with change 1 of 13 December 1996) promulgated these policy changes in directive format. Just another change, not hardly!

The March 1996 polices are revolutionary. *This is Not Business as Usual!* The major thrusts of the new policies are teamwork (integrated product teams), teamwork with industry, tailoring, empowerment, only performing value-adding tasks, employing Cost As an independent Variable (CAIV), a preference for commercial items, and use of best practices. This guide will expand on these themes.

1.4 NATIONAL PERFORMANCE REVIEW

In March 1993, President Clinton announced an initiative to "reinvent government" called The National Performance Review (NPR). In Vice President Gore's Third Report of the NPR (1996), the following statement is made in Chapter 1:

> "If you're a citizen, you ought to be able to expect good services from your government. If you run a business, you ought to be able to expect reasonable treatment by regulators — treatment that meets legitimate public needs without crushing yours. And as a taxpayer, you ought to be able to expect that the government, acting as your trustee, is managing your tax dollars wisely. And the federal government shouldn't expect applause when it finally straightens things out to give the American people this kind of treatment.
>
> "But the point is, this has never happened before. Despite 11 major exercises in government reform this century, there's been little lasting change."

The 1994 report went on to note that federal spending exceeds 23 percent of the economy, and that the Department of Health and Human Services, the Department of Defense, and the Department of the Treasury *each* spend three times annually what America's largest corporation, General Motors,[1] takes in revenue.

Chapter 4 of the 1994 report of the NPR notes that because the 1993 agreement between the Administration and Congress will keep spending tight for the foreseeable future, the federal government must find ways to spend the money it has more effectively. The situation requires, in essence, a new philosophy of governing that places a premium on cost-effectiveness. In a section on red ink, the report states, in part:

> "What the government needs, then, is a new, more efficient way to deliver basic services. ... A key element in the revised deficit forecasts are [sic] strict new caps on annual spending."...

This Chapter concludes:

> "Forced to do better — to provide improved customer service at lower costs — agencies and employees need the management principles and philosophies embedded in *From Red Tape to Results* and this year's anniversary update (1993 and 1994 references noted above). They contain the key to effective governing, the method of performing within the box of fiscal constraint."

[1] Budget of the United States Government: Fiscal Year 1995, p.157

The latest NPR reports for 1996 are benchmarking studies, which include industry participation and deal with resolving customer complaints.

1.5 END OF THE MONOLITHIC SOVIET CHALLENGE

The Cold War between the United States and ultimately its Western allies, against the Soviet Union and ultimately the Warsaw Pact, lasted from shortly after the end of World War II (Berlin Airlift, 1947) until 1992.

During this 45-year period, the United States and its allies engaged in political and military combat, both directly and indirectly (through surrogates), with the monolithic threat of the Soviet Union for control over the Eurasian land mass. The winning strategy for the United States came first from forging a coalition of nations in the late 1940s, intervention in the Korean War and the building of NATO in the 1950s, the build-up of strategic forces in the 1960s, establishing relations with China in the 1970s, and the United States arms build-up of the 1980s. Errors were also made by the Soviets along the way. According to Zbigniew Brzezinski, President Carter's national security adviser, American policy (foreign and military) may not have been brilliant and, at times, it was overly defensive, but it was steady.[2]

The breakup of the Soviet Union has not ended all threats to U.S. national security. Accordingly, "The primary task of the Armed Forces of the United States will remain to deter conflict — but, should deterrence fail, to fight and win our nation's wars. In addition, we should expect to participate in a broad range of deterrent, conflict prevention, and peacetime activities."[3]

1.6 PUBLIC DEMAND FOR DOWNSIZING GOVERNMENT

1.6.1 The Current Threat

The prior two sections provide some of the logic driving Congress to downsize government by taking aim at a reduced annual federal budget deficit. This action began in the early nineties and continues today. As the Department of Defense downsizes its very large proportion of the federal government in terms of people and appropriated funds, consideration must continue to be given to threats to the security of the United States and DoD's role in implementing the President's foreign policy. Previously existing threats to the United States have shifted and diminished, while new threats have evolved. Currently (1997), the principal threats to U. S. interests are North Korea, political/military developments in Russia, continuing Middle East instability, and the proliferation of technology associated with weapons of mass destruction in the hands of various rogue nations. Add to this transnational and subnational conflicts, some of which may impact U.S. interest. Thus, with the world's major militaries now in a decade of transition (the end points of which are not entirely clear) we face a high degree of uncertainty regarding the nature of

---

[2] Brzezinski, Zbigniew "The Cold War And Its Aftermath," *Foreign Affairs*, p. 31, Fall 1992.
[3] Joint Vision 2010, Chairman Joint Chiefs of Staff, John M. Shalikashvili, General, USA.

the threats that will confront U.S. interests in the early 21st century. In addition, the end of the Cold War is still playing itself out, and as a result of decreasing threat perceptions and generally declining defense budgets (China being a notable exception), militaries are not enjoying the resource prominence they once did. In summary, direct threats to the security interest and territorial integrity of the United States have declined over the last several years, but mid-range dangers and long-range uncertainties continue to be at the forefront of U.S. national security policy.[4]

The national security of the U.S. is made up of a strategy that has three components: prevent and reduce the threat, deter the threat, and defend against the threat. The first component, prevention, consists primarily of treaties with other nations together with diplomatic and other cooperative activities. The second, deter, involves the strategic nuclear forces that have been the bulwark of that deterrence for nearly half a century. To the extent these first two components are not fully successful, we have to be prepared to defend directly against a threat. Thus, defenses, in varying degrees and with various levels of urgency, are linked to the threat from a range of weapons and several groups of nations. The weapons still include strategic ballistic missiles plus developing medium, and short-range ballistic missiles and land-attack cruise missiles. Any of these weapons can be armed with nuclear, biological, or chemical warheads. The threat from some nations with large inventories of these weapons is currently quite low, while the threat from other nations who want to own these weapons may be relatively high. The nations with large inventories include Russia and mainland China. Other nations getting special attention include North Korea and a group of rogue nations such as Iraq.[5]

1.6.2 Downsizing

The end of the Cold War has resulted in a deliberate major reduction in all aspects of the armed forces of the United States. The execution of this reduction has been referred to as downsizing. It has also caused a major reduction to take place in the capacity of the defense industry. Downsizing has resulted in a restructuring of our defense acquisition process based on modern management techniques and the adoption of best practices, as appropriate, from the private sector and from within DoD.

1.6.2.1 Downsizing To Date. A summary of downsizing until the present was provided by the Secretary of Defense when he said, "The forces which we use today to carry out our deter or defeat strategy are dramatically changed from the Cold War days. Since the mid-1980s, we have cut our defense budget by 40 percent, cut our forces by 30 percent — to include withdrawing two-thirds of the ground forces and three-quarters of our air forces from Europe, and cut our weapon acquisition by 70 percent. At the same time, we

[4] This paragraph adapted from *Defense Issues*, Vol. 10, Nr. 5, "The Worldwide Threat to U.S. Interest," a prepared statement of Lt. Gen. James R. Clapper, Jr., USAF, Director, Defense Intellegence Agency, to the Senate Armed Services Committee, Jan. 17, 1995.

[5] Adapted from *Defense Issues*, Vol. 11, Nr. 92, "Dark Clouds of Nuclear War Threat Fading, But Not Gone," prepared remarks by Paul G. Kaminsky, USD(A&T), to the Military Research and Development and Procurement subcommittees, House National Security Committee, Sept. 27, 1996.

discarded our strategies designed to fight a major war in Europe and developed new strategies and tactics for deterring and fighting regional conflicts. We reoriented our training centers to focus on this kind of conflict as well as other potential threats. For example, in order to get ready for Bosnia, we turned one of our training centers in Germany into a mini-Bosnia, complete with burned-out villages, refugees and paramilitary forces. And finally, we focused on quality — quality weapons systems, quality people and quality living conditions for our troops and their families."[6]

Contributing to downsizing are several DoD initiatives and administration policies.

1.6.2.2 Modernization. Modernization does not only mean new systems or upgrades to existing systems. It also means joint planning and joint training. It means small procurements of essentials such as tactical communications, trucks, ammunition, armored personnel carriers, etc. When applied to a major program such as shipbuilding, modernization means a submarine or surface combatant being fully capable of participating in joint operations. Thus, the jointness aspect of modernization takes a lot of training, cooperation, and trust among the Services. It is not easy, but it is critically important. Modernization when combined with readiness in the context of a smaller force structure, in the words of former Secretary of Defense Perry, gives us more than mere technological superiority; it gives us a force that is capable of dominating any potential foe across the full spectrum of military operations. In this regard, the Deputy Undersecretary of Defense for Acquisition Reform noted early in 1995 that in what was then the 10th year of declining defense budgets, it was time to start investing in modernization again in view of the fact that the cascading effect of modern equipment going to a smaller number of troops had run its course.

The base realignment and closure process is also linked to modernization and long-term readiness. Former Secretary of Defense Perry stated that as we downsize the military force, we must also reduce our Cold War infrastructure. Future efforts will be aimed at correcting the imbalances between force structure and infrastructure that remain.

1.6.2.3 Science and Technology (S&T). The emphasis placed on this area was best explained by Secretary of Defense Perry in May 1996 when he noted, "The challenge for the Department's science and technology program is to put the best available technology into the hands of the customer — the warfighter — in a way that is timely and cost effective both tomorrow and far into the future. Doing this requires close, continuous and effective interaction between our warfighters and our technology managers. It also requires maintaining a world-class base of people and facilities. We have such a base today. I am committed to maintaining it into the future. Our Science and Technology program will keep our warfighters at the cutting edge of new technology and ensure our dominance on future battlefields."

[6] *Defense Issues*, Vol. 11, Nr. 97, "A pragmatic U.S.-Russian Partnership," prepared remarks by SecDef William J. Perry to the Military Academy of the Russian General Staff, Moscow, Oct. 17, 1996.

1.6.3 Paucity of New Program Starts

Clearly the Department of Defense is pursuing fewer major system development programs and has been provided with significantly reduced R&D and procurement funds as compared with the recent past. In fact, the real value of defense spending has declined in each of the last 11 years since 1986 — through the last three years of the Reagan administration, through Desert Storm and the Bush administration, and now through the Clinton administration. This trend began before the fall of the Berlin Wall and has spanned two Republican and one Democrat administration.[7] Continuing pressure will be exerted to further reduce the defense budget in the years to come. This, combined with the change in threat noted above, results in the paucity of new program starts (in 1997). Thus, the issue may be, how to make the best of this?

The former Under Secretary of Defense (Acquisition & Technology) Paul Kaminski was promoting three points in this regard: the continuation of a movement from separate defense and commercial industrial sectors to one integrated industrial base, furthering defense industry restructuring and consolidation, and expanding the opportunities for armaments cooperation and using that cooperation to better integrate and rationalize our industries. He also gave emphasis to increasing DoD reliance on dual-use technologies, products, and processes.

Today's global economy allows everyone, including potential adversaries, to gain increasing access to the same commercial technology base. This increased access is further justification for DoD to pursue a dual-use strategy in order to break down the barriers between commercial and defense industries, to realize the benefits of commercial-military integration in both research and development and in manufacturing, to increase the pace of innovation in defense systems, and to reduce the cost of such systems. The bottom line is that we have no choice but to move from separate industrial sectors and marry the momentum of a vigorous, productive, and competitive commercial industrial infrastructure with the unique technologies and systems integration capabilities provided by our defense contractors.

The world-wide defense industry is dealing with excess capacity. Mergers and combinations of companies are taking place in the United States. For many countries in Europe, aerospace firms with long and distinguished histories have been privatized, merged, or even closed. Industrial base considerations are becoming more important to our national and international security postures. In the interest of caution, DoD has conducted assessments of some sectors of the U.S. defense industry to determine what capabilities are essential to support our defense needs; whether or not those capabilities are truly unique; and whether or not those capabilities are "endangered." In 1996, the department completed studies of the industry supporting conventional ammunition and tracked combat

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[7] *Defense Issues*, Vol. 11, Nr. 85, "Defense Industry Challenges and Opportunities," prepared remarks by USD(A&T) Paul G. Kaminski to the Silicon Valley/Space Consortium 2nd Annual Silicon Valley Defense Acquisition Conference, Santa Clara, Calif., July 11, 1996.

vehicles, bombers, helicopters, destroyers, nuclear power plants for submarines, expendable space launch vehicles, the D-5 missile, and torpedoes. These studies indicate that although DoD programs will not sufficiently sustain all of the companies currently engaged in defense-related businesses, the scale and mix of the DoD programs will adequately sustain nearly every required industrial capability. The two conclusions are that there are virtually no sectors where the capability is endangered; and DoD should not take direct action to preserve those capabilities.[8]

As previously noted, on both sides of the Atlantic defense industrial sectors are downsizing. The United States still has perhaps another 10 -percent reduction ahead, and DoD will continue to face pressures to reduce its budget. DoD is dealing with this environment of fewer new program starts and all of the implications of this reduction, including the implementation of a dual-use strategy and a broad program of acquisition reform to better integrate the defense and commercial industrial base.[9]

1.7 WHY ACQUISITION REFORM NOW

In a 15 March 1994 memo, former Secretary of Defense William J. Perry promulgated his 9 February 1994 paper, *Acquisition Reform — A Mandate For Change*, to the senior leadership within the Department of Defense. In stating the problem and why change was necessary, Secretary Perry noted in his paper that, "The Post-Cold War era poses a new set of political, economic, and military security challenges for the United States: regional or limited conflicts; proliferation of weapons of mass destruction, both nuclear and non-nuclear; risks to its economic well-being; and the possible failure of democratic reform in the former Soviet Bloc and elsewhere. The President and Secretary of Defense are committed to maintaining the U.S. military's edge over opponents. That means maintaining superior people, training, logistics, and weapons system technology — the advantage the U.S. now has that allows us to deter aggression, and to prevail quickly with minimum casualties when required to employ force. The President and Secretary of Defense are committed to maintaining a lean, high-tech, agile, ready-to-fight military force during a time in which: the threats are changing and unpredictable; by Fiscal Year 1997 defense spending will have declined in real terms by over 40% from FY85; and advanced technology is increasingly available to the world."

Examples given in the acquisition reform paper of situations or processes that justified "Acquisition Reform" in 1994, some of which still require work in 1997, and beyond, include:

- The foundation upon which our national security strategy has been built was undergoing significant change.

- The DoD procurement rules that had prevented DoD from acquiring state-of-the-art commercial technology and prevented full use best commercial practices.

[8] *Defense Issues,* Vol 11, Nr 84, Paul Kaminski, USD(A&T), Warsaw, Poland, June 21, 1996
[9] *Ibid.*

- The DoD policies that had prevented the Department from buying from certain companies even when the price was cheaper.

- The years of contractor and DoD staff work that had been needed to obtain policy waivers to allow DoD to save procurement dollars.

- The unwillingness of contractors to incur the costs of complying with government unique and costly contract terms in order to sell to DoD.

- The DoD's excessively high cost of doing business, a portion of which is due to telling contractors how to do the job as opposed to providing performance specifications.

- The practices within DoD that prevented the rapid acquisition of commercial technology.

- The failure of DoD to consider life-cycle costs at all times.

- The need to free up resources for modernization while maintaining the DoD force structure and readiness levels.

Former Secretary Perry indicated initiatives relative to these problems and many more had been addressed in recent years. He noted that Cost As an Independent Variable (CAIV) is essential to DoD surviving ever-decreasing budgets. He further stated that much remains to be done in terms of acquisition reform, particularly adjustments to restrictive laws relative to outsourcing. Therefore, re-engineering the acquisition process has been and will continue to be a high DoD priority. Acquisition processes must be able to respond to external changes. DoD faces new national security challenges, a drastically reduced budget, reduced influence in the marketplace, and technology that is changing faster than the system can respond; and that technology is available to the entire world. The point was made that we must design an acquisition system that can get out in front of these changes instead of reacting to them.

1.8 TECHNOLOGY EXPLOSION

> "Our forces are being designed to achieve dominant battlefield awareness and combat superiority through the deployment of fully integrated intelligence systems and technologically superior weapons systems. 'Dominant battlefield awareness' means knowing everything going on in a battlefield — everything within an area that can measure up to 200 kilometers by 200 kilometers. The primary objective is to know where all the enemy forces are. It also means knowing similar information regarding all friendly forces as well. However, dominant battlefield awareness is much more than knowing the static location of forces.

> "Commanders will need to know the combat readiness status of 'state vector' for each force element. This includes knowing the logistics posture of friendly and enemy forces as well as having a prediction of the resupply needs of each force element. There is a strong linkage between dominant battlefield awareness and total asset visibility — without the latter, the former is seriously degraded. To complete the logistics picture, available support and the need for future support must be propagated from each force element in the field throughout the whole support system. It will require a seamless logistics system, one with *modernized information systems* and improved, assured *communications.*"
>
> —Paul G. Kaminsky, USD(A&T), 1996, Foreword to *DoD Logistics Strategic Plan.*

1.8.1 Telecommunications

Rapid gains in telecommunications permit the transfer of information at speeds and in quantities only dreamed of in years past. For the first time, the battlefield commander has the opportunity to receive comprehensive real-time information relative to the entire battlefield; subject to the appropriate deployment of data-gathering sensors such as satellites, ground and airborne radars, infrared sensors, etc.; and open (unjammed) communication links. The Joint Surveillance and Targeting Attack Radar System (JSTARS) is under development to provide a meaningful portion of the sensor suite and telecommunications network. During the early stages of Operation Joint Endeavor, JSTARS was given its operational christening as an Advanced Concept Technology Demonstrator in Bosnia. To support Implementation Forces (IFORs) in Bosnia, DoD is improving force communications capabilities in two ways. First, in order to provide direct broadcast communications capability, commercial television satellite technology is being used. Second, DoD is fielding a wide bandwidth, secure tactical Internet connection through fiber and commercial satellite transponders. These communications allow war planners and logisticians, on the ground in Bosnia, in the European Command headquarters in Germany, and in the Pentagon, to have access to the same data at the same time. This access is available to virtually anyone with a 20-inch receiver antenna, cryptologic equipment, and authentication codes. Local commanders have a 5,000-mile remote control to select the programming that they receive over their 24 megabits-per-second downlinks from direct broadcast satellites. That power in telecommunications holds great potential for modernizing the DoD logistics support system. The attainment of full, real-time, worldwide asset visibility is a high DoD priority.

1.8.2 Computers

The explosive growth rate in computer capability and the steep decline in the cost of computers are common knowledge. Numerous DoD development efforts are underway to

apply current computational powers to operational and logistics uses. Computer technology, spawned by the military but now fully exploited by capable commercial entities, has been combined with telecommunications technology in an effort to attain real-time worldwide logistics asset visibility.

1.8.3 Increased Potential for Flexible Logistics

During the 1980s, the military posture of the United States focused on the major threat posed by the Soviet Union. Following the collapse of the Soviet Union in 1989, a number of regional conflicts flared up. In several cases, the United States played a role with its military forces, either for humanitarian purposes or to further our national interests. Current DoD plans foresee a near-term future in which regional conflicts persist but which is devoid of a major military threat as characterized by the 45-year Cold War. The logistics implications associated with this scenario once again dictate the attainment of full, real-time worldwide asset visibility, rapid deployment of forces and support assets, and a need for rapid manufacturing and positioning of logistics elements.

1.8.4 Multinational Corporations for Worldwide Support

With defense posture focused on regional conflicts, efforts are underway to develop a network of multinational corporations with overseas suppliers to provide a significant portion of logistics support at points closer to potential future conflicts. The Gulf War demonstrated the enormity of the task of positioning a major force, together with its logistics tail, adjacent to a potential or actual conflict that is thousands of miles from the continental United States. As the Services shift toward a leaner, faster, better logistics system, the availability of supply sources in Europe and in the Far East should significantly lessen the burden on the transportation system and reduce supply response times.

1.9 LOGISTICS STRATEGIC PLAN

The previously noted *Logistics Strategic Plan* (1996/1997 edition) was prepared by the Deputy Under Secretary of Defense (Logistics) and promulgated 22 June 1996 by Under Secretary of Defense (Acquisition and Technology). The plan states:

> "The changing threat requires that logistics be flexible, mobile, integrated, compatible, and precise in targeting support to the point of need. These qualities depend on highly reliable, near real-time information, which will become one of the logisticians' foremost allies in the future. At the same time, investments are needed to "engineer" costs out of the logistics tail. Some of these investments are in the logistics system itself, while others will be needed to reduce the cost of maintaining complex system components. Achieving world-class capabilities, while reducing the cost of DoD's logistics system, is the principal

challenge of this Plan. The logistics system of the Department is part of the Nation's industrial and logistics capability; and a rebalancing of public and private sector logistics delivery methods is essential to ensure both best value and best results."

In urging all DoD Components to incorporate the Plan into their management programming and budgeting priorities, the following is offered by the plan:

Logistics System Mission Statement

"To provide responsive support to ensure readiness and sustainability for the Total Force in both peace and war."

Vision

"The DoD Logistics System will:

"Provide reliable, flexible, cost-effective and prompt logistics support, information, and services to the warfighters;

"Achieve a lean infrastructure;

"The DoD Logistics System will meet this vision proactively by making selective investments in technology; training; process reengineering; and employing the most successful commercial and government sources and practices."

1.10 <u>FOCUS ON LIFE-CYCLE COSTS EFFICIENCY AND USE OF COMMERCIAL BEST PRACTICES</u>

1.10.1 Outsourcing and Privatization[10]

1.10.1.1 <u>Definitions</u>. (quoting from the referenced Defense Science Board Report)

- "Outsourcing
  - "Transfer of a support function previously performed in-house to an outside service provider.
  - "Service provider usually given extensive flexibility regarding how it performs the outsourced function.

[10] Adapted from Report of the Defense Science Board Task Force on *Outsourcing and Privitization,* OUSD(A&T), August 1966.

- "Privatization
    - "A type of outsourcing involving the transfer of government assets (depots, data centers, etc.) to the private sector.
    - "Government sheds capability to perform the outsourced task.
    - "Most DoD outsourcing initiatives do not involve privatization."

1.10.2 Background

Outsourcing and privatization will become increasingly important in the next few years. Full implementation is critical to freeing up the funds essential to force modernization. In the words of the former Under Secretary of Defense (Acquisition and Technology), Paul G. Kaminski:

> "DoD must continue to reduce its infrastructure and support costs to increase funding for modernization in the coming years. Introducing the competitive forces of the private sector into DoD support activities will reduce costs and improve performance. Outsourcing is not a theory based on uncertain assumptions. Experience in DoD and the private sector consistently and unambiguously demonstrates how the competitive forces of outsourcing can generate cost savings and improve performance. One need only glimpse at the operation of our nation's most successful companies to see the dramatic benefits that they realize through outsourcing and competition."

Similarly, a Defense Science Board (DSB) task force that studied outsourcing and privatization stated that outsourcing and privatization should not be viewed as an end to itself, but as the only practical approach to free-up the resources needed to ensure the continuing military superiority and technological leadership of the U.S. Armed Forces.

The DoD is unlikely to obtain significant additional resources for modernization from further infrastructure consolidation, at least in the midterm. The Base Realignment and Closure (BRAC) Commission completed its most recent round of base closure action in 1995. While the BRAC process is for the first time generating net savings in 1996 (Transition costs of base closure actions are often high.), these savings have already been incorporated into the current Future Year Defense Program. Moreover, congressional interest in authorizing another BRAC round any time soon is open to question.

1.10.3 The Support Structure

Full-time equivalents (FTEs) are defined as the man-years of work elements performed by military or DoD civilian individuals that could be performed by non-DoD commercial activities. In FY94, the number of FTEs was 640,000 (that number has since diminished to an estimated figure of 500,000). Of the 640,000 FTEs, over one-third performed depot-

level or intermediate maintenance. Base services and health services together were the other major sources of commercial activity FTEs. These categories account for almost three-quarters of all commercial FTEs reported in FY94.

1.10.4 Private Sector Experience

U.S. firms increasingly outsource a wide range of support functions to outside vendors. Information technology (IT) was the first major function outsourced beginning in the mid-1980s. In 1996, IT outsourcing still represents a major share of all outsourcing activity. Business logistics, manufacturing, and finance and administration are other support functions with strong outsourcing trends.

1.10.5 Public Sector Experience

In summary, the public sector already has extensive, highly successful experience with outsourcing. Despite its flawed approach to outsourcing, DoD has obtained significant cost savings and other benefits from its somewhat limited efforts to transfer support functions to the private sector. However, the Department has outsourced only a small portion of IT commercial activity workload (25 percent of 850,000 positions that were involved in commercial-type activities).

DoD success stories include:

- Air Force base support: outsourcing all functions.
  - — Selected CONUS bases (e.g., Vance).
  - — Overseas bases (e.g., Incirlik).

- Other functions have had strong outsourcing successes:
  - — DLA materiel management.
  - — Individual skill training.
  - — Depot-level maintenance/overhaul.

- In-theater outsourcing results: responsive, reliable support
  - — Telecommunication in Vietnam War.
  - — Range of key support functions in Desert Shield/Desert Storm,
  - — Haiti, and Bosnia.

- Direct vendor delivery (DVD):
  - — Vendor delivers against DLA contract directly to customer.
  - — Improves response, reduces inventory and infrastructure.
  - — DVD is $1.4B or 32 percent of FY95 sales; FY97 goal is 50 percent

- Prime vendor contracts:
  - — Customers deal directly with vendor.

— Medical is key example:
  – DLA medical inventory reduced 61 percent since 1961.
  – Price reduction of 25 to35 percent and 24-hour response time.
— Sale of $560M in FY95; goal is $41.2B in FY99.

Results of Navy In-house/Commercial Competitions (an example):

- The Center for Naval Analysis analyzed the results of more than 800 Navy competitive contract awards conducted 1978 to 1990 when in-house activities openly competed with commercial activities (in accord with OMB Circular A-76 guidelines, hereafter referred to as A-76). As a result of the competitions, both the Navy and the outside vendors achieved savings averaging 20 to 30 percent. The analysis also indicates that A-76 actions tended to focus on relatively narrow functions involving few government employees. More than half involved fewer than 10 employees; less than 10 percent involved more than 55 workers. The data also indicates that outsourcing savings were highest when vendors took over function traditionally performed by military personnel. In such cases, the Navy realized savings of nearly 50 percent of function cost. This savings rate reflects the relatively high cost of military personnel, including fringe benefits. The analysis also revealed the impact of outsourcing on the quality and responsiveness of support functions, and found transferring workload to outside vendors resulted in no significant quality problems.

1.10.6 Impediments

The DSB study, which was initiated in October 1995 by the USD(A&T), recorded that in January 1996, the Deputy Secretary of Defense noted, "The hardest things to change are institutions that have been successful and need to change anyway." DoD has been very successful but changes are needed to ensure that the United States continues as the world's preeminent military power, which in this case involves freeing funds for force modernization.

According to the study, the primary impediments to the implementation of an aggressive DoD outsourcing strategy include statutory restrictions and congressional micromanagement; the time-consuming and complicated nature of the DoD procurement process; the complexity and lack of equity in A-76 public/private competitions; the lack of adequate government cost data to support such competitions; DoD policies to preserve inhouse capabilities to perform certain "core" maintenance tasks; and the resistance of the DoD culture to fundamental change.

In another area, acquisition reform has not fully addressed the unique problems and requirements associated with service contracts. For example, DoD contracting officers frequently lack adequate expertise in the service being procured. Because of this lack of functional expertise, they often do not have a comprehensive understanding of the contract terms and conditions that are most needed to be effective for a particular service.

Moreover, vendors report that DoD continues to base vendor selection primarily on hourly labor rates. Past performance, reputation, and reengineering potential are not generally emphasized in the proposal evaluation process. The DoD procurement process also fosters formalized, distant, and sometimes adversarial relationships between vendors and DoD contract oversight personnel. Private sector experience suggests that an interactive, more collaborative approach is key to effective management of complex service contracts. Finally, in the current environment there are few incentives for the military services to pursue an aggressive outsourcing program. Base commanders are not evaluated on their effectiveness in outsourcing support functions and, in fact, are predisposed to protect the job security of their staff. Moreover, the Services fear that savings achieved from outsourcing are likely to be diverted to other functions, which is indeed the case if funds are to be found for force modernization.

Privatization presents serious problems for the DoD. These problems include an unwillingness on the part of industry to operate what was once a government operated facility with the same number of employees and with the same compensation package previously used by the government doing the same work effort. In addition, several statutes place restrictions on how much DoD depot-level workload can be converted to the private sector. The primary impediment is 10 U.S.C. 2469 which states that no depot level workload over $3 million being performed by a depot-level activity of the DoD may be performed by a contractor unless the Secretary of Defense uses competitive procedures for the selection of such contractor; and further, the provisions of A-76 shall not apply in this selection.

1.10.7 Proposed Strategy and Recommendations

The DSB task force report shows that it is possible to achieve an estimated annual savings of $7 to $12 billion from outsourcing by FY02. The key elements of an aggressive strategy to achieve this goal follow: (1) outsourcing all support functions that can be performed cheaper and/or more effectively by the private sector; (2) reducing emphasis on A-76 public/private competition, i.e., accept that A-76 is seriously flawed and discourages outsourcing; (3) taking full advantage of A-76 waivers and exemptions; (4) focusing on military billets; (5) eliminating statutory and institutional impediments; and (6) structuring an aggressive plan and holding senior managers accountable.

Numerous recommendations are offered that are DoD-wide in nature. In October 1996, the USD(A&T) stated, "I believe we are truly moving beyond adherence to the old conventional wisdom that dictated that we own all capabilities tied to support for the warfighter. We have selectively tested the effectiveness and efficiency of outsourcing various logistics support functions and they have been successful. Our immediate challenge now is to move forward with widespread deployment of similar outsourcing privatization efforts across a broad front."

1.11 JOINT VISION 2010

This Chairman of the Joint Chiefs of Staff 1996 document is a conceptual template for how America's Armed Forces will channel the vitality and innovation of its people and leverage technological opportunities to achieve new levels of effectiveness in joint warfighting. This vision of future warfighting embodies the improved intelligence and command and control available in the information age and goes on to develop four operational concepts: (1) dominant maneuver, (2) precision engagement, (3) full dimensional protection, and (4) focused logistics.

In terms of missions, tasks, and strategic concepts, Joint Vision 2010 states that the primary task of the armed forces, as noted above, will remain to deter conflict. But, should deterrence fail to fight and win our nation's wars, America's strategic nuclear deterrent, along with appropriate national-level detection and defensive capabilities, will likely remain at the core of American national security. However, the bulk of our Armed Forces will be engaged in or training for worldwide military operations. In these operations, we will largely draw upon our conventional warfighting capabilities. We will fight if we must; but we will also use these same capabilities to deter, contain conflict, fight and win, or otherwise promote American interests and values.

In defining focused logistics, the vision statement notes that the other three operational concepts rely on our ability to project power with the most capable forces, at the decisive time and place. To optimize the three non-logistic concepts, logistics must be responsive, flexible, and precise. Focused logistics will be the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while en route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical levels of operations. It will be fully adaptive to the needs of our increasingly dispersed and mobile forces, providing support in hours or days versus weeks. Focused logistics will enable joint forces of the future to be more mobile, versatile, and projectable from anywhere in the world.

Logistics functions will incorporate information technologies to transition from the rigid vertical organizations of the past. Modular and specifically tailored combat service support packages will evolve in response to wide-ranging contingency requirements. Service and Defense agencies will work jointly and integrate with the civilian sector, where required, to take advantage of advanced business practices, commercial economies, and global networks. Active and reserve combat service support capabilities, prepared for complete integration into joint operations, will provide logistics support and sustainment as long as necessary.

Information technologies will enhance airlift, sealift, and pre-positioning capabilities to lighten deployment loads, assist pinpoint logistics delivery systems, and extend the reach and longevity of systems currently in the inventory. The combined impact of these improvements will be a smaller, more capable deployed force. It will require less continuous

support with a smaller logistics footprint, decreasing the vulnerability of our logistics lines of communications.

1.12 ASSUMPTIONS ABOUT THE FUTURE LOGISTICS ENVIRONMENT

The following logistics assumptions broadly represent intended courses of action or perceptions as stated by various individuals in DoD leadership roles; however, at this time (1997) they cannot be stated as fact.

- The focus will shift from global to highly diverse, regional conflicts — for peacekeeping, humanitarian, or combat missions — and demand agile logistics support.

- Streamlining to a leaner logistics system can be achieved through a tighter integration of business and production processes.

- Military and commercial ships and aircraft available to carry military equipment to both improved and unimproved locations will continue to be a con-straint to deploying forces.

- Logistics information has become a principal commodity of the logistics system.

- The industrial base, upon which logistics support relies, will continue to experience an overall reduction in defense logistics-related work.

- DoD Continuous Acquisition Life-Cycle Support (CALS) (see Chapter 18) must allow for the exchange of data/drawings in support of an aging DoD inventory, including the few new items entering the inventory over the next decade. Legacy data in an automated form is of paramount importance.

- System complexity will increase; but continued improvements in reliability, maintainability, and deployability, will encourage changes to traditional logistics concepts.

- The United States will need to continue to support its systems in foreign inventories while relying more on offshore sources.

- Petroleum will remain the major source of mobility energy; but commitments will increase to develop alternative clean fuels.

- The demand will decrease for some sources of conventional ammunition.

- The DoD *Logistics Strategic Plan,* Edition 1996/1997, pages 6-8, lists numerous additional logistics assumptions.

1.13 THE QUADRENNIAL DEFENSE REVIEW — 1997

The final report from the 1997 Quadrennial Defense Review (QDR) was released in May, 1997. The QDR was "global" in nature and examined not only force size and structure but also force modernization and logistics support. The following points were made that are relevant to the subject of acquisition logistics:

- "A Revolution in Business Affairs (RBA) has begun. The RBA includes: reducing overhead and streamlining infrastructure; taking maximum advantage of acquisition reform; outsourcing and privatizing a wide range of support activities when the necessary competitive conditions exist; leveraging commercial technology, dual-use technology, and open systems; reducing unneeded standards and specifications; utilizing integrated process and product development (IPPD); and increasing cooperative development programs with allies."

- The goals set forth in *Joint Vision 2010* are the foundation for a broader effort to exploit the Revolution in Military Affairs (RMA). Focused logistics integrates information superiority and technological innovations to develop state-of-the-art logistics practices and doctrine. This will permit us to accurately track and shift assets, even while en route; thus, the delivery of tailored logistics packages and more timely force sustainment at the strategic, operational, and tactical levels of operations will be facilitated. Focused logistics will reduce the overall size of logistics support and help to provide more agile, leaner combat forces that can be rapidly deployed and sustained around the globe.

- "Initiatives such as Joint Total Asset Visibility and the Global Combat Support System will provide deployable, automated supply and maintenance information systems for leaner, more responsive logistics."

- Initiatives have been adopted that will reduce Defense agency and Defense-wide infrastructure personnel and costs. Among these are plans to outsource selected Defense Logistics Agency functions, including cataloging and increasing competition for disposal and physical distribution.

- Within the military departments, initiatives are being reviewed to:

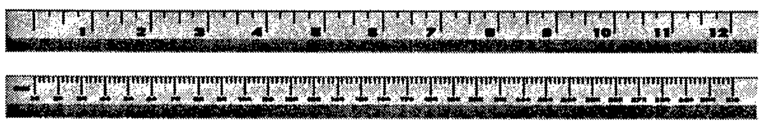
  — Reduce logistics support costs by integrating organizations and functions (supply, financial, automated data processing, transportation, maintenance, and procurement) that are now being performed at multiple locations into a common geographic area and by eliminating redundant facilities and operations.

  — Compete, outsource, or privatize military department infrastructure functions that are closely related to commercial enterprises. Most of these actions involve logistics and installation support functions.

1.14 A FEW OBSERVATIONS

A number of trends, which significantly impact the character and management of the logistics support function, have emerged over the past three decades. Some of these trends (shown in figure 1-1) involve changes in aircraft fleet sizes, sorties per aircraft, radar reliability, the length of the technology cycle, the character of Defense Department technology, and the size of the defense industrial base. They are representative of changes throughout the U.S. arsenal of weapon systems.

LOGISTICS EVOLUTION



	Good Old Days 1960s — 1980s	**Now** 1990s — 2000s
Fleet Sizes	Thousands	Hundreds
Sorties	1 – 2 per day	3 – 4 per day
Reliability	<10 hr F-4 Radar	>100 hr F-16 Radar
Technology Cycle	Slow – Years	Fast – Months
Defense Technology	Leading Edge	Following Edge
Industrial Base	Defense – Big	Defense – 2%

Figure 1-1: Logistics Evolution

In the following paragraphs, the candid and sometimes terse comments and observations, offered in 1995 and 1996 by several senior DoD leaders, are summarized. They set a tone, albeit unofficial, for this guide. These comments are offered in the context of the 5000-series directives and other DoD policy statements; and they urge tailoring, innovation, and risk-taking in program management.

The current DoD logistics system is too close to a "just-in-case" system with little or no in-transit asset visibility and a lack of a fast, responsive distribution. This system is in stark contrast to the "just-in-time" systems being implemented by commercial enterprises and our own industrial partners. Neither the "just-in-case" nor "the just-in-time" system are right for the Defense Department. A tailored approach that is close to a lean "just-in-time" system is needed. Reducing cycle times is all-important! Further, our logistics will never be structured properly until full information systems are available to provide total asset visibility. Our support base is too costly. Based on questioning by senior leaders, it is clear that PMs do not know the nature of support cost for their programs. We need better models to understand the "cost base" of our programs. DoD should look to the commercial world to see how products are supported. Airlines used to be like DoD is

today. Now they have a small support base and look to the manufacturer for support. Much room exists for innovative thinking in logistics. DoD is accustomed to periodic big buys that are warehoused and then distributed. Instead, we need to move to catalogue buying for overnight delivery, which is now being used in a few cases for mess hall meals, uniforms, lumber, steel, and support of some medical facilities.

Other observations include comments on the Single Process Initiative (SPI), which needs to be applied in our contracts. Progress thus far has all been in the area of quality and manufacturing. We need an SPI focus in the area of business practices, i.e., financial management, RFPs, and proposals. First- and second-tier subs and base-level DoD people are not adequately aware of, nor do they fully use, SPI. Relative to solicitations and proposals, every effort should be made to keep the cost down to both government, on preparation, source selection, and award, and to industry on responses to RFPs. In this regard, several new and innovative ideas developed, including the use of constrained written proposals as a preview document for the government. This preview document is offered prior to a contractor's official oral presentation of its proposal and demos and, if applicable, with the cost proposals following. Demos can be costly for a contractor; therefore, consideration can be given to taping the presentations for subsequent reviews. Prior to RFP release, contractors should be interviewed and encouraged to share all the information the law allows. Thus, only qualified contractors will participate; and both parties will not waste resources. The contract community fails to understand what the new law authorizes them to do in the context of increased freedom.

The acquisition community must grasp interoperability in the same context as does the user. Common architecture and open communications are key. Contract Data Requirements Lists (CDRLs) are sometimes nearly useless. Get agreements with contractors on CDRL type tasks. Big incentives are a good government management tool and necessary in today's world. PMs need to understand industry's financial incentives. The operational Requirements Document (ORD) is where industry is going to look for an understanding of requirements. However, have the user talk to the contractor rather than just read the ORD. Be in a position to tell the contractor that if he fails to perform, he will be replaced. Use Commercial/Nondevelopmental Item (NDI) for modification programs that will be around for only 10 years or less. Program managers must make IPT people accountable. IPTs tend to break down fiefdoms. The release of an item to a foreign government must be worked out very early in a program, or Foreign Military Sales (FMS) money will be lost to the program. On Commercial/NDI, if you strip away military layers you will find a commercial system underneath; but you may also find old technology. Thus, will a new system really save a user costs? Money is the one big problem for all PMs.

In the eyes of DoD senior leadership, many of the tools needed by logistics managers involve change; they include:

- Change in program funding thresholds related to moving dollars (DoD rules not laws).

- Better use of modeling and simulation so all requirements can be more completely considered.

- Better LCC models with people trained to use them.

- Better application of commercial technology and production methods. Copy industry's ways. They are not perfect but they know how to cut cycle times. Industry has the data when they need it to perform such tasks.

- Employment of commercial support for contingencies. The Civil Reserve Air Fleet (CRAF) aircraft program is a good example of where DoD has kept a "core" capability but has used commercial resources.

- Use of allies. This is important because: (1) our forces are not alone anywhere in the world, (2) it is politically strengthening, and (3) costs are shared and offsets need to be adequate. Congressional legislation, which may give the Secretary of Defense waiver authority on "Buy American," is in progress.

1.15 REDUCING LOGISTICS CYCLE TIMES

Reducing logistics cycle times is one of the three major goals stated in the DoD *Logistics Strategic Plan* (1996/1997). The plan states that, "Time is the enemy of logistics. Each day of delayed response to the user represents millions of dollars in inventories waiting to be moved, repaired, delivered, stowed and used. Slow cycle times: (1) are symptomatic of processes that need to be improved, eliminated, or outsourced to high quality providers; (2) ... reflect gaps in required management information. ... and (3) ... are caused by standards that do not challenge logistics managers ..." The plan goes on to state: "The best private sector practitioners of logistics have distinctly moved towards reducing cycle times. Customers demand quicker and more reliable response — whether they are manufacturers seeking to minimize holdings of parts and assemblies, or typical consumers buying merchandise from catalogue sales outlets." Rapid response capability is essential for:

- supporting a mobile force;

- responding to multiple contingencies;

- responding with the most current knowledge of operational requirements;

- minimizing investment — either in materiel or repair work — that can become obsolete or that is not immediately relevant to mission needs;

- reducing investment in facilities and related infrastructure; and

- increasing customer confidence.

1.15.1 Reduce Logistics Response Time

The previously noted plan states that quality support for a smaller, more mobile force with a smaller logistics infrastructure requires a major shift towards customer needs and customer measures of logistics system performance. Slow response times, for example, drive the need for increased inventory levels and undermine the customers' confidence in the supply system. The plan describes a response time "goal" as, "By September 1997, reduce average logistics response times by one-third from a baseline based on a first quarter FY 96 average. By October 2001, reduce the average age for backordered items to 30 days." In the first case, this would be from 24 to 16 days for all of DoD. Transportation is a major element of logistics response time. The other elements include time required to submit, receive, and process a requisition; picking the supply items; packaging them for shipment; holding for transportation; and receiving and distributing the requisitioned items.

1.15.1.1 Transportation. A review of a major segment of the transportation element may provide some insight into the response time issue. In FY94, the Defense Logistics Agency's (DLA) Continental United States (CONUS) freight shipments totaled approximately 3,413 million pounds and incurred $178,350,000 in transportation charges for rail, truckload, less than truckload (LTL), small package – surface, small package – air, and air freight services. Nearly 90 percent of those shipments were moved as small packages or airfreight; but rail, truckload, and LTL shipments accounted for more than 95 percent of the weight and approximately 80 percent of the cost. Since nearly 90 percent of DLA's shipments are transported by small package or air freight carriers and the majority of those shipments move less than 900 miles, DLA's transit times are typically three days or less.

When benchmarking DoD's standards for transit times with those of commercial industry, the Logistics Management Institute (LMI) found that the latter were often more stringent. As an example, comparing industry state-to-state transit time standards with those specified in government guaranteed traffic (GT) agreements, 48 percent of the commercial LTL transit time standards range from one to four days better (i.e., shorter) than the corresponding GT standards. Further, 69 percent of the commercial truckload standards range from one to three days better than the corresponding GT standards. Not only are many commercial standards shorter than DoD's, but they are continuously improving because of the competition among carriers in the commercial marketplace.

The comparison of standards suggests that, when industry standards are better than DoD standards, DoD should be able to systematically reduce many of its transit times at no additional cost by incorporating industry state-to-state transit time standards into both GT agreements and the Defense Traffic Management Regulations. This brings us back to best commercial practices. This suggests that DoD may want to explore awarding GT agreements on the basis of best overall value to DoD, not just on the bid price. Consequently, LMI recommended that the Military Traffic Management Command and DLA develop a best-value GT agreement that requires carriers to propose both rates and transit times for DoD consideration. Nearly 90 percent of DLA's shipments are moving by premium

transportation with most experiencing transit times of three days or less. Nonetheless, they support the position of the USD(A&T) in saying that further improvements are possible.

1.15.2 Summary

- Use of technology can decrease cycle time.
- Budget constraints are forcing changes toward a leaner, more efficient logistics response structure.
- Much can be learned from the commercial world, where competitive pressures have led to innovative procedures to reduce logistics response time.

2
WHAT IS LOGISTICS?

Logistics: Getting the Right Thing to the Right Place at the Right Time.

2.1 CURRENT DEFINITIONS

Swiss Baron Antoine Henry Jomini, in his 1838 *Summary of the Art of War*, made the first significant use of the term "logistics" by defining it as the practical art of moving armies. Admiral Henry Eccles, in his 1959 book, *Logistics in the National Defense,* states that the word "logistics" is an abstraction like the other abstractions of "strategy, tactics, economics, or politics." Thus, logistics is not susceptible to a single, simple, and permanent definition. It is a broad field of endeavor consisting of many interdisciplinary activities ... that, when applied together, constitute the art and science of logistics. John Mosher adds that logistics is an ancient art and an emerging science.

The International Society of Logistics Engineers (SOLE) states that the word "logistics" comes from the Greek word that deals with mathematical calculations, while its French usage relates to the supplying, quartering, and movement of troops. The United States gave the word a much broader definition, that of total support of a product during its system life cycle. SOLE goes further to define logistics as "the art and science of management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans and operations."

Carl Henn, in the "SOLE Member's Handbook," further defines logistics as "... the integrated design, management and operation of physical, human, financial and information resources over the lifetime of a product, system, or service. In economic terms, it creates *time and place utility* in contrast to *form utility* ..."

John Mosher observes that logistics is a broad field of endeavor consisting of many interdisciplinary activities; but to be characterized as logistics, these and other related functions/activities must be performed, managed, and organized as integrated systems and subsystems. He observes that the depth of knowledge implied for the professional personnel involved (in logistics) is considerable. He states that it is certainly more than one could reasonably expect to find within a single individual and that the necessary systems viewpoint (with proper attention to details) suggests a team composed of experts.

2.2 STRATEGIC LOGISTICS

Strategic Logistics is perhaps the most unexplored area of logistics — the term doesn't even appear in Brimer & Livermore's *Encyclopedia of Logistics Terms*. Martin Binkin, in *Support Costs in the Defense Budget*, observes that defense support is one of the least understood parts of the defense program; and its precise relationship to national security has not been defined. Carter & Merritt, in Chapter 1 of *Mobilization and the National Defense*, state that no recognizable core of primary literature exists which defines the scope and depth of mobilization concerns. They also describe existing literature as being a disjointed, fragmented, and piecemeal collection. The Defense Secretary's Commission on *Base Realignments and Closures*, reports that an ad hoc commission should not become a routine means for addressing subjects that are a part of the day-to-day business of governing. The Commission recommended that an ongoing base-management process be established — clearly an area of strategic logistics.

The Joint Chiefs of Staff have recognized the importance of strategic logistics and, in their proposed final publication of the *Basic National Defense Doctrine (Joint Pub 0-1)*, they define strategic logistics (in the general sense) as the art and science of harnessing the economic and societal strengths of a nation for national defense. In the specific sense, strategic logistics is the process of planning for, coordinating, and allocating the manpower, materiel, infrastructure, and services required for military needs, war production needs, and civil sector needs. It requires coordination between the executive and legislative branches, state governments, and industry. Force generation and mobilization are inclusive components of strategic logistics. Figure 2-1 portrays the division between strategic logistics and applied logistics.

Several years ago, the Air Force Association observed, in *Lifeline in Danger: An Assessment of the United States Defense Industrial Base,* that the number of firms doing defense work, especially at the supplier and subcontractor levels, has been declining for decades and has had a most harmful effect on the nation's defense posture. Thus, domestic industry has difficulty in meeting peacetime, let alone wartime, defense needs.

Von Clausewitz, in *On War*, states the importance of knowing the ènemies' means and potential of waging war (the prevailing conditions of the state) — their cash reserves, treasury and credit, as well as the size of their fighting forces. In Sun Tsu's Sixth Century BC book, republished as *The Art of War*, he observed that national unity was an essential requirement of victorious war; but he cautioned against conducting a protracted war, since the resources of the state would not suffice when the army engaged in protracted campaigns. He observed that those who were adept in waging war do not require a second levy of conscripts; nor did they require more than one provisioning.

Writers have postulated that strategic logistics, in the commercial sense, will achieve greater future importance than strategic logistics, in the military sense. Richard Rosecrance, in *The Rise of the Trading State*, contends that nations are becoming so

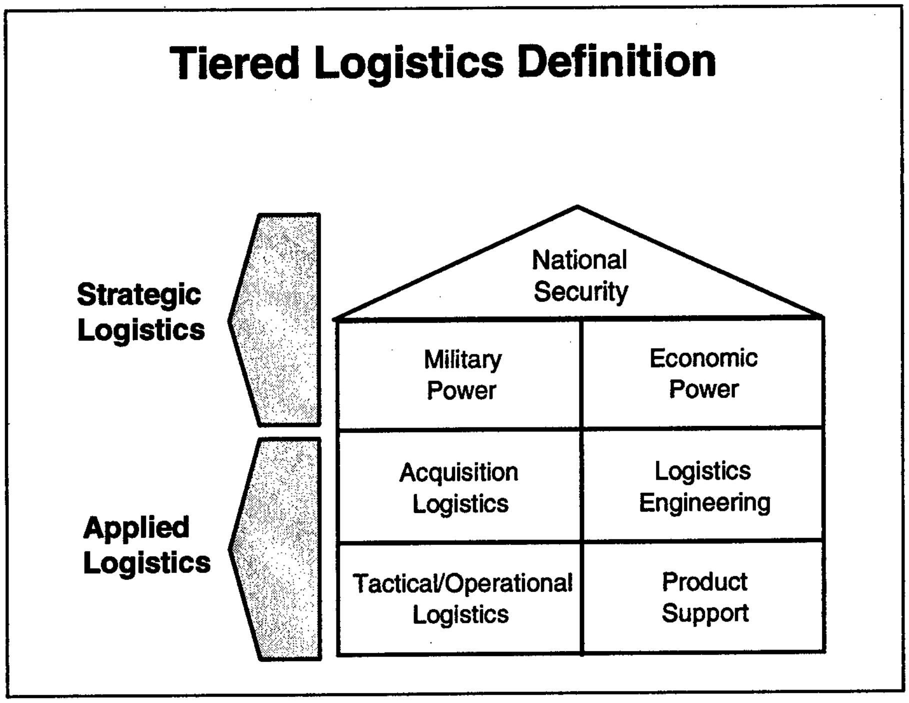


Figure 2-1: Tiered Logistics Definition

economically interdependent as to lessen their tendency to fight one another. Trade, not military might, is now the path to world power. If the real battlefield of tomorrow is the global economy, then strategic logistics — the industrial base and resources of a country (both military & civilian productive capacity) — is of primary importance to our national security and greater attention is warranted.

Alvin and Heidi Toffler, in *War and Anti-War*, take an opposite view and contend that geo-economic conflict will never be a substitute for war; it is often a prelude or provocation to actual war. Wars have resulted from irrationality, miscalculation, xenophobia, fanaticism, and religious extremism when every "rational" economic indicator suggested that peace was preferable.

2.3 APPLIED LOGISTICS

Jim Jones, in the first edition of his *Integrated Logistics Support Handbook*, captures the essence of applied logistics by dividing it into two phases. Phase 1 (commonly referred to as acquisition logistics or logistics engineering) includes everything that is done to plan and acquire support before a system is delivered to the user. Phase 2 (commonly referred to as tactical/operational logistics or product support) includes the things that are done to support the system while it is being used. He notes that actions that occur during Phase 1 dictate how well the system will be supported during Phase 2.

2.3.1 Acquisition Logistics & Logistics Engineering

Acquisition logistics or logistics engineering primarily occurs before the system enters the use phase and is placed in the hands of the customer. (Modifications and product improvements extend the time frame of acquisition logistics.) Tactical/operational logistics commences when the customer starts to use the system.

For contemporary systems, acquisition logistics, or logistics, engineering never really goes away — especially for a modern system. In "America's High Noon Complex," published in the Sep–Oct '94 *Army RD&A Bulletin*, Norman Augustine described the situation the best. He observed that our military hardware is now on a replacement cycle of about 54 years and that world technology typically has a half-life of from 2 to 10 years. Thus, system/subsystem modifications, changes, improvements, and the like constitute the norm for military systems that may see service lives in excess of 50 years.

Although some commercial systems (such as the DC-3 aircraft, with a service life in excess of 50 years, or the San Salvador Island lighthouse, with a service life in excess of 100 years) may see extended service lives, this is usually not widespread. Commercial customers are more prone to replace/upgrade their systems, and commercial manufacturers are more prone to facilitate system replacements or upgrades. The "new and improved" product, the "newest and latest" model, and the "all new" model are typical commercial terms that belie this phenomenon. Longevity, however, still remains the bellwether of a good design.

The acquisition logistics/logistics engineering function serves as the advocate for the most supportable design from among the feasible design alternatives. These functions are summarized as follows:

> IDENTIFYING the Operational Requirements Document (ORD) logistics constraints and defining the resultant logistics support requirements (relative to **each** support element) for each proposed design alternative (while the alternative exists only on paper) is a most difficult job. It requires analytical/engineering skills and the ability to communicate in the language of the design engineer.
>
> ADVOCATING the selection of the most easily supported design alternative involves communicating the logistics support implications of each design alternative to the other members of the Integrated Product Team (IPT).
>
> INFLUENCING the emergence of this design creates cost-effective/supportable detailed design decisions.
>
> REFINING the logistics support requirements (relative to **each** element) to reflect the particulars of the emerging design involves ensuring that the logistics support requirements are defined to the same depth and at the same pace as the emerging design.

TESTING & EVALUATING, based on this real-time definition, is a function that involves planning logistics support for the product/system during developmental/engineering tests and during all early field/operational tests. Successful tests will validate the workability of the planned support.

ACQUIRING all necessary items of support involves ensuring that the system definition and procurement includes both the system/product/service and all requisite items of support for each element. Producing the system and its requisite support items (in quantity) is a necessary follow-up. The real common interest of the manufacturing and logistics communities is producing a quality product that conforms to the design through the reduction of variability in the manufactured design. The reduction of variability leads to products that perform better during the use phase and require less maintenance because they break down less. Thus, the manufacturing and logistics communities have a strong, common area of interest.

PROVIDING the system to the customers in the right place, at the right time, and in the right quantities is done through the execution of a good support plan and/or a first-rate fielding plan.

IMPROVING the system through the inevitable change/modification process is another important function.

These functions represent the core activities of an acquisition logistics member of an Integrated Product Team (IPT), and they are reiterated in Figure 2-2. Note that the execution of a modification program after the system has been produced requires each acquisition logistics/logistics engineering function to be repeated. Thus, acquisition logistics/logistics engineering (in a world of rapidly changing technology) never really goes away.

2.3.2 Tactical/Operational Logistics & Product Support

Tactical/Operational Logistics is perhaps the oldest area of logistics. Van Creveld, in *Supplying War*, defines logistics as "the practical art of moving armies and keeping them supplied." He further observes that logistics, an admittedly unexciting aspect of war, makes up as much as nine-tenths of the business of war.

Kenneth Brown in his National Security Essay, *Strategies: the Logistics-Strategy Link,* addresses the "classic" definition of this area of logistics as commonly associated with the tail of the metaphorical beast that represents the forces with which we wage war. Furthermore, the tooth-to-tail comparison usually contends that more teeth and less tail always makes for a better "fighting animal."

ACQUISITION LOGISTICS FUNCTIONS

Identify	the support.
Advocate	the best design alternative.
Influence	detailed design.
Refine	at the same pace and depth as the rest of the IPT.
Foster	T&E of both system and support system.
Acquire	the support.
Provide	the support to the user.
Improve	the support.

Figure 2-2: Acquisition Logistics Functions

The Joint Chiefs of Staff, in their proposed final publication of the *Basic National Defense Doctrine (Joint Pub 0-1)*, take a classically military viewpoint and define logistics as the science of planning and carrying out the movement and maintenance of forces.

Ben Blanchard, in *Logistics Engineering and Management*, addresses product support in the commercial sector to include such activities as material flow, product distribution, transportation, warehousing, and the like. His more general definition, in *Systems Engineering and Analysis,* is well-suited to defining product support as the composite of all considerations needed to assure the effective and economic support of a system throughout its programmed life cycle.

Most modern manufacturers of durable goods realize the importance of a responsive product support organization and the cost of a dissatisfied customer. The goal of providing excellent performance or at least satisfactory use in service remains. Interest in this area is currently intense.

2.4 IMPLICATIONS

Acquisition Logistics, at its best, requires a "problem prevention" mentality. Operational logistics, on the other hand, generally needs a "problem solving" mentality. Strategic logistics generally requires a "strategic thinking" mentality — someone who sees the "broadest picture."

In the introduction to the 1917 publication, *Pure Logistics*, Stanley Falk stated that the word "logistics" has been in use in the United States for more than a century. For most of this period, people have had difficulty in agreeing on its precise definition. Even to-day, the meaning of logistics is somewhat inexact. In the same book, Lt Col George Thorpe argued that a proper definition {of logistics} was essential for understanding the true role and function of logistics, for ensuring that none of its aspects were neglected, and for achieving ultimate victory in any conflict.

Heskett, Glaskowsky and Ivie, in *Business Logistics: Physical Distribution and Materials Management*, observe that the use of clearly defined terms can provide time savings; but it has taken marketing and production scholars and executives six decades to organize their terminology in a usable, time-saving, and almost universally understandable form. Jomini introduced the term "logistics" in 1838. The time has come to seek a universal definition of logistics.

3

DEPARTMENT OF DEFENSE ACQUISITION POLICY

Successful acquisition programs are fundamentally dependent upon competent people, rational priorities, and clearly defined responsibilities.

DoDD 5000.1

3.1 <u>REQUIREMENTS</u>

3.1.1 Authority and Methodology

Department of Defense Directive 5000.1, of 15 March 1996, Subject: Defense Acquisition, in accordance with Office of Management and Budget (OMB) Circular A-109, establishes a disciplined, yet flexible, management approach for acquiring quality products that satisfy the operational user's requirements. Such an approach must effectively translate operational needs into stable, affordable acquisition programs. The policies stated in DoDD 5000.1 apply to all elements in DoD and are intended to forge a close and effective interface among the Department's three principal decision support systems, which are the:

- Requirements Generation System,
- Acquisition Management System, and the
- Planning, Programming, and Budgeting System.

Within the Acquisition Management System, all the tasks and activities needed to bring a program to the next major milestone occur during an acquisition phase. Phases provide a logical means of progressively translating broadly stated mission needs into well-defined, system-specific requirements and ultimately into operationally effective, suitable, and survivable systems. These systems are also intended to provide the operational user with measurable improvements to mission accomplishment in a timely manner and at a fair and reasonable price. As previously noted, the applicable policies and principles that govern the operation of the defense acquisition system and guide all defense acquisition programs are stated in DoDD 5000.1 and are divided into the three major policy areas that follow:

- Translating Operational Needs into Stable, Affordable Programs;
- Acquiring Quality Products; and
- Organizing for Efficiency and Effectiveness.

3.1.2 Major Themes

- Teamwork. The employment of Integrated Product Teams (IPTs), in an environment encouraging Integrated Product and Process Development (IPPD), is strongly emphasized in DoD 5000.2-R. Chapter 4 of this Guide is devoted to this topic.

- Tailoring. As in the past, all programs must accomplish certain core activities. However, acquisition personnel are now encouraged to tailor the acquisition process and streamline the reporting and documentation process in accord with common sense and sound business management practice. The few reports and report formats dictated by the new DoD 5000.2-R are those described in Appendices I-IV of that regulation.

- Empowerment. DoDD 5000.1 and DoD 5000.2-R reflect current efforts to empower program management personnel and their vendors to do the best they can. Those documents canceled many directives that previously dictated rigid actions and reporting requirements. Program Managers (PMs) do not have to ask permission to take actions that are otherwise permitted by law and are within the scope of their charters.

- Cost As an Independent Variable (CAIV). Henceforth, acquisition managers and their respective weapons system user representatives must consider both performance requirements and fiscal constraints. Responsible cost objectives must be set for each program phase. Chapter 14 is devoted to this topic.

- Commercial Products. The new directives mandate that DoD fully implements the statutory preference for the acquisition of commercial items by federal agencies. Acquisition of commercial items, components, processes, and practices provides rapid and affordable application of fast-paced commercial technologies to validated DoD mission needs.

- Best Practices. Acquisitions of the future must take into account customary commercial practices in developing acquisition strategies and contracting arrangements.

3.1.3 Key Officials and Forums

Program definition is the process of translating broadly stated mission needs into a set of operational requirements from which specific performance specifications are derived. In the area of requirements, a key official is the Vice-Chairman of the Joint Chiefs of Staff (VCJCS). The key forum is the Joint Requirements Oversight Council (JROC), chaired by the VCJCS. The JROC, in the case of Acquisition Category (ACAT) I programs, is responsible for conducting requirements analyses, validating mission needs and key perform-

ance parameters, and developing recommended joint priorities for those needs. As of 1 January 1997, law under Title 10 establishes the existence of the JROC and its functions. It should also be noted that the Office of the Secretary of Defense (OSD) Principal Staff Assistants (PSAs) represent the user community in the functional area under their direction on acquisition and requirements matters for Automated Information Systems (AISs). Within the Acquisition Management System, there is a clear linkage between the analysis of alternatives, system requirements, and system evaluation measures of effectiveness.

After the JROC validates the mission need for an ACAT I program, the Under Secretary of Defense for Acquisition and Technology (USD(A&T)) shall:

- convene a Milestone 0 Defense Acquisition Board (DAB) to review the Mission Need Statement (MNS);
- identify possible materiel alternatives; and
- authorize concept studies, if they are deemed necessary.

For ACAT IA programs, the JROC, or the cognizant OSD PSA, validates the mission need and process integrity in compliance with DoDD 8000.15; and the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C^3I)) convenes a Milestone 0 Major Automated Information System Review Council (MAISRC). A favorable Milestone 0 decision does not yet mean that a new acquisition program has been initiated. Further, when acquisition programs are initiated in response to a military threat, they are based on authoritative, current, and projected threat information.

3.1.4 Mission Need Statement (MNS)

DoD Components document deficiencies in current capabilities and opportunities to provide new capabilities in the MNS expressed in broad operational terms. The MNS shall:

- identify and describe the mission deficiency and discuss the results of mission area analysis;
- describe why non-materiel changes (i.e., doctrine, tactics, etc.) are not adequate to correct the deficiency;
- identify potential materiel alternatives; and
- describe any key boundary conditions and operational environments, such as information warfare, that may impact satisfying the need.

The MNS is prepared in accordance with Commander, Joint Chiefs of Staff (CJCS) Memorandum of Policy (MOP) 77. System performance objectives and thresholds are developed from, and remain consistent with, the initial broad statements of operational

capability. The requirements are refined at successive milestone decision points as a consequence of cost-schedule-performance tradeoffs during each phase of the acquisition process.

In summary, all acquisition programs are based on identified, documented, and validated mission needs, which result from ongoing assessments of current and projected capability. Thus, mission needs may be designed to establish a new operational capability, to improve an existing capability, or to exploit an opportunity to reduce costs or enhance performance.

3.1.4.1 Cost Objectives. Upon approval of an MNS, an approach is formulated to set and refine cost objectives. By program initiation (usually Milestone I), each ACAT I and ACAT IA PM establishes life-cycle cost objectives for the program through consideration of projected out-year resources, recent unit costs, parametric estimates, mission effectiveness analysis and trades, and technology trends.

3.1.5 Evaluation of Requirements Based on Commercial Market Potential

Researching the potential of the commercial marketplace to meet system performance requirements is an essential element of building a sound set of requirements. In developing system performance requirements, DoD Components evaluate how the desired performance requirements could reasonably be modified to facilitate the use of potential commercial items, components, specifications, standards, processes, technology, and sources. The results of the evaluation are included as part of the initial Operational Requirements Document.

3.1.6 Operation Requirements Document (ORD)

At each milestone, beginning with program initiation (usually Milestone I), thresholds and objectives are documented by the user or user's representative in an ORD. These thresholds and objectives are initially expressed as measures of effectiveness or performance and minimum acceptable requirements for the proposed concept or system. Thresholds and objectives in the ORD are designed to consider the results of the analysis of alternatives and the impact of affordability constraints. Key Performance Parameters (KPPs), validated by the JROC, are included in the appropriate Acquisition Program Baseline (APB). A KPP is a system capability or characteristic so significant that failure to meet the threshold can be cause for the concept or system selection to be reevaluated or for the program to be reassessed or terminated. KPPs are extracted from the ORD and included in the APB. Thus, user or user representative participation in each acquisition phase is essential.

Thresholds and objectives are defined below. The values for an objective or threshold and definitions for any specific parameter contained in the ORD, Test and Evaluation Master Plan (TEMP), and APB shall be consistent.

Threshold. The threshold value is the minimum acceptable value that, in the user's judgment, is necessary to satisfy the need. If threshold values are not achieved, program performance is seriously degraded, the program may be too costly, or the program may no longer be timely. The spread between objective and threshold values is individually set for each program and is based on the characteristics of the program (e.g., maturity, risk, etc.).

Objective. The objective value is the value desired by the user and the value the PM is attempting to obtain. The objective value could represent an operationally meaningful, time-critical, and cost-effective increment above the threshold for each program parameter. Program objectives (parameters and values) may be refined based on the results of the preceding program phase(s).

3.1.6.1 Performance, Engineering, or Design Changes. The Cost Performance Integrated Product Team (CPIPT) (normally led by the PM or the PM's representative) is empowered to recommend to the PM performance or engineering and design changes as long as the threshold values in the ORD and APB can be achieved. If the changes require ORD/APB threshold value changes, the leader of the CPIPT notifies the PM and the Overarching Integrated Product Team (OIPT) leader. The PM ensures that the changes are brought before the ORD and/or APB approval authorities for decision. The CPIPT has responsibility for integrating and evaluating all cost-performance tradeoffs analyses conducted.

3.1.6.2 Operational Requirement Document (ORD) and Testing. Test and evaluation strategy shall reference the ORD as follows:

- Test planning, at a minimum, addresses all system components (hardware, software, and human interfaces) that are critical to the achievement and demonstration of contract technical performance specifications and operational effectiveness and suitability requirements from the ORD.

- Quantitative criteria are phrased so they provide substantive evidence for analysis of hardware, software, and system maturity and readiness to proceed through the acquisition process. Linkage shall exist among the various Memoranda of Effectiveness (MOEs); Memoranda of Performance (MOPs), which are used in the analysis of alternatives or the ORD; and test and evaluation. In particular, the MOEs, MOPs, the ORD criteria, the analysis of alternatives, the TEMP, and the APB shall be consistent.

- Operational test and evaluation (OT&E) programs shall be structured to determine the operational effectiveness and suitability of a system under realistic conditions (e.g., combat) and to determine if the minimally acceptable, ORD-specified operational performance requirements have been satisfied.

3.1.7 Acquisition Strategy and Life-Cycle Support

Each PM develops and documents an acquisition strategy that serves as the roadmap for program execution from program initiation through postproduction support. In developing an acquisition strategy, a primary goal is to minimize the time and cost of satisfying an identified, validated need that is consistent with common sense and sound business practices. The acquisition strategy evolves through an iterative process and becomes increasingly more definitive in describing the relationship of the essential elements of a program. Essential elements in this context include, but are not limited to, sources, risk management, cost as an independent variable, contract approach, management approach, environmental considerations, and source of support. The PM addresses other major initiatives that are critical to the success of the program.

The acquisition strategy includes the critical events that govern the management of the program. The event-driven acquisition strategy explicitly links program decisions to demonstrated accomplishments in development, testing, initial production, and life-cycle support. The events set forth in contracts shall support the appropriate exit criteria for the phase or preceding development events that are established for the acquisition strategy.

The acquisition strategy is tailored to meet the specific needs of individual programs, including consideration of incremental (block) development and fielding strategies. The benefits and risks associated with reducing lead time through concurrency are specifically addressed in tailoring the acquisition strategy. In tailoring an acquisition strategy, the PM addresses the management requirements imposed on the contractor(s).

The PM initially develops the acquisition strategy at program initiation (usually Milestone I) and keeps the strategy current by updating it whenever there is a change to the approved acquisition strategy or as the system approach and program elements are better defined. The PM develops the acquisition strategy in coordination with the Working-level Integrated Product Team. The Program Executive Officer (PEO) and Component Acquisition Executive (CAE), as appropriate, concur in the acquisition strategy. The Milestone Decision Authority (MDA) approves the acquisition strategy prior to release of the formal solicitation. This approval usually precedes the milestone review, except at program initiation when the strategy usually is approved as part of the initial milestone decision review.

Paragraphs 3.3.1 through 3.3.8 of DoD 5000.2-R address acquisition-strategy related topics including:

- sources of supplies and/or services;
- risk management;
- Cost As an Independent Variable;

- contract approach;
- management approach;
- environmental, safety, and health considerations;
- sources of support; and
- warranties.

3.1.7.1 Non-Traditional Acquisition. The Department must be prepared to plan and execute a diverse variety of missions. To meet the user's needs in a timely manner, the acquisition system must be able to rapidly insert advanced technology directly into the warfighter's arsenal. To accomplish this goal, the acquisition system must demonstrate new and improved military capabilities on a scale adequate to establish operational utility and affordable cost. Demonstrations based on mature technologies may lead to more rapid fielding. Where appropriate, managers in the acquisition community make use of non-traditional acquisition techniques, such as Advanced Concept Technology Demonstrations (ACTDs), rapid prototyping, evolutionary and incremental acquisition, and flexible technology insertion.

3.1.7.2 Performance Specification. In solicitations and contracts, standard management approaches or manufacturing processes are not required. Performance specifications are used when purchasing new systems, major modifications, and commercial and nondevelopmental items. Performance specifications include DoD performance specifications, commercial item descriptions, and performance-based non-government standards. If it is not practicable to use a performance specification, a non-government standard is used. There may be cases when military specifications are needed to define an exact design solution because there is no acceptable non-government standard or because the use of a performance specification or non-government standard is neither cost-effective, practical, nor does it meet the user's needs. As a last resort in these cases, military specifications and standards use is authorized with an appropriate waiver or exception from the MDA.

3.2 LIFE-CYCLE MANAGEMENT

3.2.1 Event-Oriented Management

The Department uses a rigorous, event-oriented management process that emphasizes:

- effective acquisition planning;
- improved and continuous communications with users; and
- prudent risk management by both the government and industry.

Event-oriented means that the management process is based on significant events in the acquisition life cycle and not on arbitrary calendar dates.

3.2.2 Stability

Once DoD initiates an acquisition program to meet an operational need, managers at all levels make program stability a top priority. To maximize stability, the Components develop realistic long-range investment plans and affordability assessments. The Department's leadership strives to ensure stable program funding throughout the program's life cycle.

3.2.3 Program Objectives and Thresholds

Beginning at the inception of a new acquisition program, the PM, together with the user, proposes for MDA approval objectives and thresholds for cost, schedule, and performance that will result in systems that are affordable, timely, operationally effective, operationally suitable, and survivable. As the program matures, the PM refines these objectives and thresholds so they are consistent with operational requirements.

3.2.4 Risk Assessment and Management

PMs and other acquisition managers continually assess program risks. Risks must be well understood, and risk management approaches must be developed before decision authorities can authorize a program to proceed into the next phase of the acquisition process. To assess and manage risk, PMs and other acquisition managers use a variety of techniques, including technology demonstrations, prototyping, and test and evaluation. Risk management encompasses identification, mitigation, continuous tracking, and control procedures that feed back through the program assessment process to decision authorities. To ensure an equitable and sensible allocation of risk between government and industry, PMs and other acquisition managers develop a contracting approach appropriate to the type of system being acquired.

3.2.5 Best Practices

The PM streamlines all acquisitions so that the acquisitions contain only those requirements that are essential and cost-effective. Contract requirements are stated in terms of performance rather than design-specific procedures. Management data requirements are limited to those essential for effective control. Acquisition process requirements are tailored to meet the specific needs of individual programs. Relief or exemption is sought for those requirements that are not essential, cost-effective, or do not add value. Early industry involvement in the acquisition effort, consistent with the Federal Advisory Committee Act (FACA27), is encouraged to take advantage of industry expertise to improve the acquisition strategy. The PM avoids imposing government-unique requirements that significantly increase industry compliance costs.

3.2.6 Life-Cycle Cost Estimates

Life-cycle cost estimates are explicitly based on the program objectives, operational requirements, and contract specifications for the system. For ACAT I programs, life-cycle cost estimates are based on a program DoD Work Breakdown Structure (WBS); and, for ACAT IA programs, life-cycle cost estimates are based on a life-cycle cost-and-benefit element structure agreed upon by the IPT. Estimates are comprehensive in character. They identify all elements of cost that would be entailed by a decision to proceed with development, production, and operation of the system regardless of funding source or management control. For ACAT I programs, estimates are consistent with the cost estimates used in the analysis of alternatives. The operation and support costs are consistent with the manpower estimate. Cost estimates should be neither optimistic nor pessimistic; they should be based on a careful assessment of risks and should reflect a realistic appraisal of the level of cost most likely to be realized.

3.2.6.1 Cost/Performance Tradeoffs. Upon approval of a MNS, an approach is formulated to set and refine cost objectives. By program initiation (usually Milestone I), each ACAT I and ACAT IA PM shall have established life-cycle cost objectives for the program through consideration of projected out-year resources, recent unit costs, parametric estimates, mission effectiveness analysis and trades, and technology trends. A complete set of life-cycle cost objectives includes RDT&E, production, operating and support, and disposal costs. At each subsequent milestone review, cost objectives and progress towards achieving them will be reassessed.

Maximizing the PM's and contractor's flexibility to make cost/performance tradeoffs without unnecessary higher-level permission is essential to achieving cost objectives. Therefore, the number of threshold items in requirements documents and acquisition program baselines are strictly limited. The threshold values represent true minimums; and requirements are stated in terms of capabilities rather than technical solutions and specifications.

RFPs include a strict minimum number of critical performance criteria that will allow industry maximum flexibility to meet overall program objectives. Cost objectives are used as a management tool. The source selection criteria communicated to industry should reflect the importance of developing a system that can achieve stated production and life-cycle cost thresholds.

3.3 DOCUMENTATION

Limited Reporting Requirements. (See Appendices I-IV, DoD 5000.2-R.) Complete and up-to-date program information is an essential ingredient of the defense acquisition process. At the same time, it is important to keep reporting requirements to a minimum. Consistent with statutory requirements, PMs and other participants in the defense acquisition process are required to present only the minimum information necessary for decision authorities to understand program status and make informed decisions. (Again, refer to

Appendices I-IV, DoD 5000.2-R, for the mandatory reports and formats for ACAT I and IA programs.) The exchange of program information is facilitated by the use of IPTs.

3.3.1 Tailoring

DoD 5000.2-R presents a general model for managing Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) acquisition programs. The broad coverage of the general model acknowledges that every acquisition program is different. Any singular MDAP or MAIS does not need to follow the entire process described in the regulation. However, cognizant of this model, the PM and the MDA must structure the MDAP or MAIS to ensure a logical progression through a series of phases designed to:

- reduce risk,
- ensure affordability, and
- provide adequate information for decision-making that will provide the needed capability to the warfighter in the shortest practical time.

PMs and MDAs, for other than MDAPs or MAISs, generally adhere to the process described in Part 1 of DoD 5000.2-R; however, they tailor the process, as appropriate, to best match the conditions of individual non-major programs.

Certain core issues must be addressed at the appropriate milestone for every acquisition program. These issues are described in detail in the major sections of DoD 5000.2-R and include program structure, design, assessments, and periodic reporting. How these issues are addressed is tailored by the appropriate MDA to minimize the time it takes to satisfy an identified need consistent with common sense, sound business management practice, applicable laws and regulations, and the time sensitive nature of the requirement itself. Tailoring may be applied to various aspects of the acquisition process, including program documentation, acquisition phases, the timing and scope of decision reviews, and decision levels. MDAs promote flexible, tailored approaches to oversight and review, which are based on mutual trust and a program's size, risk, and complexity.

3.4 LOGISTICS REQUIREMENTS

3.4.1 Total System Approach

Acquisition programs are managed to optimize total system performance and minimize the cost of ownership. The total system includes:

- the prime mission equipment;
- the people who operate and maintain the system;

- how the system's security procedures and practices are implemented;
- how the system operates in its intended operational environment;
- how the system will be able to respond to any effects unique to that environment (such as Nuclear, Biological and Chemical (NBC) or information warfare);
- how the system will be deployed to this environment;
- the system's compatibility, interoperability, and integration with other systems;
- the operational and support infrastructure (including command, control, communications, computers and intelligence}
- all related training and training devices;
- data elements required by the system in order for it to operate; and
- the system's potential impact on the environment and the means for environmental compliance.

3.4.2 Supportability

Supportability factors are integral elements of program performance specifications. However, support requirements are not to be stated as distinct logistics elements; instead, they are stated as performance requirements that relate to a system's operational effectiveness, operational suitability, and life-cycle cost reduction. Accordingly, the PM ensures that a systems engineering process is used to translate operational needs and/or requirements into a system solution that includes the design, manufacturing, test and evaluation, support processes, and products. This will include transforming operational needs and requirements into an integrated system design solution through concurrent consideration of all life-cycle needs (i.e., development, manufacturing, test and evaluation, verification, deployment, operations, support, training, and disposal).

3.4.3 Acquisition Logistics

The PM conducts acquisition logistics management activities throughout the system development to ensure the design and acquisition of cost-effective, supportable systems and to ensure that these systems are provided to the user with the necessary support infrastructure for achieving the user's peacetime and wartime readiness requirements.

3.4.3.1 <u>Supportability Analyses</u>. Supportability analyses are conducted as an integral part of the systems engineering process, beginning at program initiation and continuing

throughout system development. Supportability analyses form the basis for related design requirements included in the system specification and for subsequent decisions concerning how to support the system in the most cost-effective manner over its entire life cycle. Programs allow contractors the maximum flexibility in proposing the most appropriate supportability analyses.

3.4.3.2 Support Concepts. Acquisition programs establish logistics support concepts (e.g., two levels, three levels) early in the program and refine them throughout the development process. Life-cycle costs play a key role in the overall selection process. Support concepts for new and future systems provide for cost effective, total life-cycle logistics support.

3.4.3.3 Support Data. Data requirements shall be consistent with the planned support concept and represent the minimum essential to effectively support the fielded system. Government requirements for contractor-developed support data are coordinated with the data requirements of other program functional specialties to minimize data redundancies and inconsistencies.

3.4.3.4 Support Resources. Support resources, such as operator and maintenance manuals, tools, support equipment, training devices, etc., for major system components, are not procured before the system/component hardware and software design stabilizes. The PM considers the use of embedded training and maintenance techniques to enhance user capability and reduce life-cycle costs. Where they are available, cost-effective, and can readily meet the user's requirements, commercial support resources are used.

DoD Automatic Test System (ATS) families or COTS components that meet defined ATS capabilities are used to meet all acquisition needs for automatic test equipment hardware and software. ATS capabilities are defined through critical hardware and software elements. The introduction of unique types of ATS into the DoD field, depot, and manufacturing operations are minimized.

3.5 CORE MAINTENANCE

It is DoD policy to retain limited organic core depot-maintenance capability to meet essential wartime surge demands, promote competition, and sustain institutional expertise. Support concepts, for new and modified systems, maximize the use of contractor-provided, long-term, total life-cycle logistics support that combines depot-level maintenance along with wholesale and selected retail materiel management functions. Life-cycle costs and use of existing capabilities, particularly while the system is in production, plays a key role in the overall selection process. Other than stated above and with an appropriate waiver, DoD organizations may be used as substitutes for contractor-provided logistics support, such as when contractors are unwilling to perform support or where there is a clear, well-documented cost advantage. The PM provides for long-term access to data required for competitive sourcing of systems support. The waiver to use DoD organizations must be approved by the MDA. It should be noted that recent studies (1996/97) by

the Defense Science Board have concluded that, in order to free-up funds for system modernization, the organic **core** maintenance capability retained by the DoD should be even less than that implied above.

3.6 DEVELOP A SEAMLESS LOGISTICS SYSTEM

3.6.1 Fielding Standard, Modernized Logistics Business Systems and Improving Communications of Logistics Systems

Clearly, seamless, standard, modern logistics business systems can bring many benefits to the DoD in the areas of financial accounting, management, and industrial/production operations. Thus, developing such systems is clearly a DoD goal in the context of acquisition reform. However, the launching of a new business system is a difficult technical and financial task. The costs of alternative methods of developing business systems and their operation and maintenance can, in some cases, offer little or no net economic gain or a competitive return on investment. Even the most optimum alternative for bringing a modern system into full operation may require an extended period before benefits exceed costs. In the meantime, the new system is likely to become outdated. Further, alternative solutions, which require extended payback periods, tend to rely on too many assumptions because the needed facts to support management decisions are not available. Finally, the affordability factor or financial priority for such systems, in the context of other DoD funding needs, may not be sufficient to get a new business system started, much less to get it started on an optimum course. If the system has a direct link to operational readiness, as many do, the system's affordability may be enhanced.

This being the environment impacting the initiation and maintenance of much needed new business systems, a summary of the management challenges facing a recent effort to modernize a logistics/financial system with clear readiness impact is briefly presented below. The hope is that this summary will alert the reader to the depth and breadth of representative issues encountered in the initiation or modernization of a DoD logistics business system.

The previous Defense Working Capital Fund (DWCF) (known earlier as the Defense Business Operating Fund) Corporate Board desired to increase the capability of the accounting systems that were used in the Depot Maintenance Business Area (DMBA) of the DWCF. Also, they desired to decrease the number of accounting systems in the DMBA, to increase standardization, and decrease costs.

The DWCF Corporate Board required an analytical basis to aid them in deciding whether it was preferable to:

- reduce the number of accounting systems by moving to a separate, single system for each of the three Military Departments (Option One); or

- move to a single system for all DoD DMBA activities (Option Two).

These two options resulted from an apparent conflict. The logistics community was pursuing a single depot-maintenance information system that incorporated both production and accounting capabilities while the Defense Finance and Accounting Service (DFAS) was recommending three depot-maintenance accounting systems — one for each Military Department as opposed to the several each Service now has. Therefore, the Under Secretary of Defense (Comptroller) or USD(C) was concerned that significant investments could be made in the accounting systems for each Military Department; and, shortly thereafter, a single system associated with the single production system would replace them. The USD(C) then directed that an economic analysis be performed so that the DWCF Corporate Board would have the cost information needed to make an informed decision on the preferable option.

The DFAS had already identified the candidate systems for Option One as the:

- Standard Industrial Fund Accounting System (SIFS) for the Army;
- Naval Air Systems Command Industrial Fund Management System (NIFMS) for the Navy; and the
- financial modules of the Depot Maintenance Management Information System (DMMIS) financial system for the Air Force.

Candidates for the single DoD system in Option Two were limited to those same systems.

The economic analysis concluded that Option One (a separate accounting system for each Military Department from those systems currently available) was preferable to Option Two (a single, new accounting system for all DoD depots). For the reasons stated below, the single set of production systems has not come about and is not currently planned. Instead, each Service will continue with a unique set of updated production systems that feed into the financial systems. Therefore, Option One was chosen because multiple interfaces would have to be developed for any accounting system chosen as the single, standard system (Option Two). That interface problem, combined with the unique business practices followed by each Service and the additional deployments Option Two would require, increased the investment costs of Option Two relative to Option One. Increased investment costs in the face of decreased operating and support-cost savings made a single, shared accounting system a poor choice at the time. If the depot production systems and business practices evolve toward a single system in the future, then the option of a single accounting system becomes more attractive.

While Option One was preferable, it was not uncostly. Estimating the cost of this option was essential to making decisions on the extent of system consolidation and timing. The economic analysis provided estimates of the cost of upgrading the three systems to meet the functional requirements specified by DFAS and of deploying them to all maintenance depots in their respective Military Departments.

The analysis of SIFS showed that, for a one-time investment cost of $4.9 million, SIFS could be upgraded and deployed to the three Army arsenals. Operating and support costs would remain unchanged. SIFS would improve the functionality of the existing arsenal systems and standardize DWCF accounting within the Army.

The analysis of NIFMS was more complex. Because NIFMS was being deployed first to the Navy R&D community, some costs were paid during that deployment and were not paid again by the DBMA community. The total one-time investment cost of upgrading NIFMS and deploying it to all Marine Corps and Navy maintenance depots ranged from $23.2 million (at the 50 percent confidence level) to $27.8 million (at the 90 percent confidence level). Because some of this cost was shared with the R&D community, the incremental investment cost was $17.4 million to $19.9 million. As a result of deploying NIFMS, the operating and support costs increased for Marine Corps logistics bases, naval ordnance centers, and naval shipyards.

The investment costs of deploying NIFMS to naval shipyards were substantial ($11.7 million to $13.9 million). This raised the question of whether it was less costly to upgrade the existing financial management system at the shipyards rather than replace it with NIFMS. Another option was for NIFMS to use an open systems environment configuration; this configuration would result in significantly lower subsequent investment and operating-and-support costs.

The analysis of DMMIS raised some very serious questions. The largest cost for DMMIS may have been to make it work as advertised rather than to upgrade its functionality. DMMIS does not now accurately report costs of depot maintenance. Further, the DMMIS financial subsystems, alone, did not provide coverage for all of an Air Logistics Center's (ALC's) workload. The costs of these and other needed repairs were uncertain. Deployment costs to date at the Warner-Robins ALC had been substantial, yet the system is not yet running properly. Nonetheless, the economic analysis estimated $5 million to $15 million for upgrading DMMIS to DFAS standards; about $3 million for deploying DMMIS to Warner-Robins ALC and Oklahoma City ALC; and $2 to $3 million for developing and deploying supplemental systems to cover all ALC workload. This did not include the cost of fixing the DMMIS financial subsystems so that they worked properly or the cost of fixing and validating retained systems.

In summary, the costs of business systems can range from those that are easily estimated to those that have an estimate with a low level of confidence and a poor cost/benefit ratio or return on investment. Affordability or relative funding priority will always be an issue. These problems are often tied to technical uncertainty and poorly understood risks. However, as with all engineering matters, the application of solid systems engineering skills, appropriate testing, and other tailored DoD acquisition policies and best commercial practices can create an environment in which well-justified programs can succeed.

4

INTEGRATED PRODUCT AND PROCESS DEVELOPMENT (IPPD)

"IPPD is a management technique that simultaneously integrates all essential acquisition activities through the use of multi-disciplinary teams to optimize the design, manufacturing, and supportability process. ... IPTs are the key to making IPPD work."

Secretary of Defense Memo of 10 May 1995

4.1 BACKGROUND

In order to lay the groundwork for Integrated Product and Process Development and Integrated Product Teams (IPTs), a brief discussion of related events is presented that tends to justify the decision to employ IPPD and show their relevance to the current business environment and the DoD acquisition process.

4.2 GLOBAL CHANGES

To a great extent, this topic deals with human skills, organizational changes, and team leadership. These are areas that have been significantly impacted by recent changes in the global environment brought about by shifts in technology, markets, labor, production, organizational focus, management emphasis, and organizational structure. Examples of each shift includes automated computational-based technologies, rapidly changing markets, management's focus on customers, a shift from an emphasis on employee control to an emphasis on flexibility, and organizations shifting to horizontal team-oriented structures. Today, because of these global business changes, organizations focus outward — external, individual performance is based on continual improvement; the relationship of workers is now team-oriented; and a leadership style, based on worker empowerment, is used. Similar changes are also occurring in the DoD.

4.3 CHANGES IN DOD

Since the late 80s and, particularly, in the 90s, DoD has undergone deep budget and personnel reductions that have resulted in major changes in acquisition management — fewer dollars, fewer people, and fewer programs. Thus, DoD cannot begin to afford to conduct the acquisition business using the processes applicable to the period prior to 1992. For

these reasons, combined with the changes in the global business environment, DoD acquisition management needs to be even more effective in its leadership while achieving new levels of flexibility and adaptability.

4.4 LEADERSHIP AND MANAGEMENT STYLE

As these global and DoD changes have occurred, a style known as team leadership has been effective. The team leader tends to place emphasis on building trust and inspiring teamwork, facilitating and supporting team decisions, expanding team capabilities, creating a team identity, making the most of team differences, and foreseeing and influencing change. This leader, in the form of an acquisition manager, operates in a framework that is affected by the global and DoD-wide changes created by industry and government downsizing. Leaders have to be proactive in setting the direction for their programs, aligning their people to the purpose of the program, and motivating those within the program office and the functional personnel who are part of the program management team. See Table 4A (at the end of this Chapter) for a list of characteristics of effective teams.

4.5 PARADIGMS

Paradigms are the models we use to screen incoming data. They influence our perceptions and judgments. We see best what matches our paradigms. Problems arise when the incoming data do not match the expectations that are created by our paradigms. As a result, we become blind to new opportunities because they do not fit our paradigms.

What are the recent paradigm changes that will have an impact upon leaders and managers in the acquisition management business? Experts have identified seven paradigm changes that are necessary for success in the 1990s. Briefly these changes are:

- quality redefined,
- continuous improvement,
- people make the difference,
- process improvement versus results,
- system thinking,
- horizontal structure, and
- teams as a system.

4.6 ORGANIZATIONS

Organizations that have not adapted to the paradigms noted previously have been classified by certain authors as "stuck" organizations. These organizations are internally driven; they make their decisions based on professional or departmental interest and not on updated information about customers' changing needs. They are also functionally focused and organized as a collection of separate functional departments or "stove pipes," which waste time and energy competing with each other for resources and rewards. The overall impact of this functional focus is reduction in quality and increase in cycle times and costs. Finally, stuck organizations are management-centered. The managers see themselves as the key players in the organization and assume a need to control almost everything. At times, this results in workers being denied the information, skills, experience, and authority they need to make improvements to the processes they are responsible for.

In contrast, organizations that have adapted to the above-noted paradigm of the 1990s have been referred to as "moving" organizations. They are customer-driven, so they can quickly and continuously understand, meet, and exceed their customers' changing expectations. They are also process-focused. They bridge the gaps between functional departments by understanding, tracking, improving, and speeding up the work processes by moving horizontally across the organization. Finally, moving organizations recognize the world is moving too quickly for managers to know enough, fast enough, about enough things, to consistently make the right decisions, to masterfully control situations, and to keep the organization from being swamped. Therefore, moving organizations become employee-involved. They undertake a systematic effort to build and benefit from the knowledge, skills, and commitment of their nonmanagers. Because of their closeness to work processes and the customer and because of their sheer numbers, nonmanagers can know enough, fast enough, to improve work processes.

The above organizational definitions and paradigm changes have brought about a need for leaders and managers to change their roles to some extent. In a traditional environment, managers determined and planned the work and "best methods," narrowly defined jobs, viewed cross-training as inefficient, regarded information as "management property," focused nonmanagerial training on technical skills, and discouraged risk taking. However, in the team environment, managers and team members jointly determine and plan the work, jobs require broad skills and knowledge, cross training is the norm, and most information is freely shared at all levels. Figure 4-1 offers a more complete comparison of the two organizational environments.

4.7 TRADITIONAL AND TEAM ENVIRONMENTS AND LEADERSHIP SKILLS

We should now begin to think of IPPD and IPTs in the context of the prior discussions, while considering the characteristics of three types of leadership skills. Addressed below, are the leadership skills that define a supervisory leader, a participative leader, and a team leader.

Traditional Environment	Team Environment
• Managers determine and plan the work.	• Managers and team members jointly determine and plan the work.
• Jobs are narrowly defined.	• Jobs require broad skills and knowledge.
• Cross-training viewed as inefficient.	• Cross-training is the norm.
• Most information is "management property."	• Most information is freely shared at all levels.
• Training for nonmanagers focuses on technical skills.	• Continuous learning requires interpersonal, administrative, and technical training for all.
• Risk taking is discouraged and punished.	• Measured risk-taking is encouraged and supported.
• People work alone.	• People work together.
• Rewards are based on individual performance.	• Rewards are based on individual performance and contributions to team performance.
• Managers determine "best methods."	• Everyone works to continuously improve methods and processes.

Figure 4.1: Comparison of Organizational Environments

The supervisory leader is skilled in directing people, explaining decisions, training individuals, managing one-on-one, containing conflict, and reacting to change. This type of leader emphasizes the top-down authority of a position and is effective in a traditional environment; but this person is less successful in a team environment. The participative leader has skills to work with employees rather than dictate to them. This type of leader involves people, gets their input for decisions, develops individual performance, coordinates group effort, resolves conflict, and implements change. The team leader moves away from the "control" world and focuses on building shared commitment, responsibility, and leadership. This type of leader builds trust and inspires teamwork, facilitates and supports team decisions, expands team capabilities, creates a team identity, makes the most of team differences, and foresees and influences change.

4.8 INTEGRATED PRODUCT AND PROCESS DEVELOPMENT (IPPD) AND INTEGRATED PRODUCT TEAMS (IPTs)

DoDD 5000.1, of 15 March 1996, states in part, "PMs and other acquisition managers shall apply the concept of IPPD throughout the acquisition process to the maximum extent practicable. ... At the core of IPPD implementation are Integrated Product Teams (IPTs)."

IPTs, sometimes called cross-functional teams, have thus become increasingly common in program management within DoD. IPTs are the heart of IPPD, a philosophy that produces an effective and efficient product that satisfies customers' needs. It systematically employs a teaming of functional disciplines to integrate and concurrently apply all necessary processes. In DoD 5000.2-R, the IPPD definition states, "One of the key IPPD tenants is multi-disciplinary teamwork through Integrated Product Teams (IPT)."

IPTs apply and build on subjects discussed before in terms of global change, team leadership, needed paradigm changes for the 1990s, moving organizations, and a team environment with a team-type leader. In addition they:

- reduce cycle times by replacing serial development with parallel development;
- facilitate reaching solutions to complex problems that transcend different disciplines and functions;
- focus the organization's resources on satisfying the customer's needs;
- provide a creative mix of people with different backgrounds, orientations, cultural values, and styles, which increases the probability of new ideas and innovations;
- provide opportunities for members to develop new technical and professional skills, learn about other disciplines, and learn how to work with people who have different styles and backgrounds; and
- provide a place where people can go for information and for decisions about a project, program, or customer.

In spite of their proliferation and advantages, some IPTs fail because senior managers do not give the team leaders training in critical interpersonal, group process, and team leadership skills. Sometimes team members are not empowered by their supervisors to fulfill their role as an IPT member. Some offices attempt to exert oversight authority in an older style of management when they really do not have oversight authority. Some offices with oversight authority over-reach their authority in violation of the spirit of IPPD and IPTs.

Many technically trained professionals lack the experience of working effectively in groups. In fact, many scientists and engineers chose their profession because it involved working independently with minimal supervision and interpersonal contact. However, as the number of IPTs increase, these professionals are being selected as IPT leaders. At a minimum, IPT leaders should be proficient in the IPT leadership elements including:

- group process skills,
- leadership empowerment,
- flexibility,
- conflict resolution,
- stakeholder relationships,
- resource allocation, and
- communications coordination.

4.9 IPPD/IPT AND LOGISTICS

As noted above, IPPD involves multidisciplinary teamwork through IPTs. Thus, the first job in a logistics IPT, is to define its membership and who is responsible for what! An acquisition logistics IPT employing "best practices" could organize as follows:

- *Purpose:* Optimize system support.
- *Activities:* Prepare/coordinate logistics plans and activities.
- *Typical team members include:*
    - — government and contractor logistics managers;
    - — design engineers and testers;
    - — logistics element representatives;
    - — users and training commands; and
    - — others as necessary (cost, contacts, etc.).

Table 4A (at the end of this Chapter) lists many of the attributes of an effective team. Having established a purpose and defined its membership, the logistics IPT will logically

need to address in greater detail its activities and related actions. These functions should include:

- **working with** the users to define their logistics constraints and requirement in the Mission Need Statement and Operational Requirements Documents;

- **identifying/defining,** through supportability analyses and other tools, the logistics support requirements for each proposed design alternative (normally done in a logistics support plan or equivalent);

- **advocating** selection of the most cost-effective, supportable system from among design alternatives;

- **influencing** detailed design decisions toward a more cost-effective, supportable design;

- **refining** logistics support plans at the same pace and depth at which the concurrent engineering team is working;

- **fostering** test and evaluation of the system and logistics support to the maximum practicable extent;

- **acquiring** all necessary items of support (previously identified in the logistics support plan) concurrently with system acquisition;

- **providing** the system and all its requisite support to users in the right places, at the right time, and in the right quantities throughout its service life; and

- **improving** logistics support through the inevitable modification, change, and improvement process.

4.10 SUMMARY

In conclusion, IPPD and IPTs have origins in the new paradigms of the 1990s that have presented the case for organizations to change from "stuck" organizations to "moving" organizations. At the same time, the organizational environments have changed from a traditional to a team environment. This has made it necessary for leaders to change their style from supervisory; to participative; and, then, to team leader. IPTs can take advantage of these changes while employing the noted and implied team and leadership skills to enhance their performance, in general, and logistics IPTs, in particular.

TABLE 4A
CHARACTERISTICS OF AN EFFECTIVE TEAM

1. Has a clear understanding of its purpose and goals.

2. Is flexible in selecting its procedures as it works toward its goals.

3. Has achieved a high degree of communication and understanding among its members. Communication of personal feeling, attitudes, as well as ideas occurs in a direct and open fashion because they are considered important to the work of the group.

4. Is able to initiate and carry on effective decision making, carefully considering minority viewpoints and securing the commitment of all members to important decisions.

5. Achieves an appropriate balance between group productivity and the satisfaction of individual needs.

6. Provides for sharing of leadership responsibilities by group members. By sharing leadership responsibilities, all members are concerned about contributing ideas, elaborating and clarifying the ideas of others, giving opinions, testing the feasibility of potential decisions, helping the group work on its tasks, and maintaining itself as an effective working unit.

7. Has a high degree of cohesiveness (attractiveness for the members) but not to the point of stifling individual freedom and submerging individual differences.

8. Makes intelligent use of the different abilities of its members.

9. Is not dominated by its leader or any of its members.

10. Can be objective about reviewing its own processes and can face its problems and adjust to needed modifications in its operations.

11. Maintains a balance between emotional and rational behavior and channels emotions into productive group effort.

Source: *The Leader Looks at Group Effectiveness,* Gordon L Lippitt and Edith W. Seashore. Leadership Resources, Inc., Fall Church, VA, 1976

PART II

THE LOGISTICS PROGRAM

5
GETTING STARTED

or

Identifying the Need, the Deficiencies, and the Constraints

5.1 <u>OVERVIEW OF THE INITIATION PROCESS</u>

The acquisition process is structured in logical phases separated by major decision points called milestones. The process begins with the identification of broadly stated mission needs that cannot be satisfied by nonmateriel solutions. Acquisition program stakeholders consider the full range of alternatives prior to deciding to initiate a new Defense Acquisition Program or Automated Information System acquisition program. Threat projections, system performance, unit production cost estimates, life-cycle costs, interoperability, cost-performance-schedule tradeoffs, acquisition strategy, affordability constraints, and risk management are major considerations at each milestone decision point, including the decision to start a new program.

At program initiation and after consideration of the views of the Working-Level Integrated Product Team (IPT) and Overarching IPT members (the latter for ACAT I and IA programs only), the PM proposes and the Milestone Decision Authority considers for approval the appropriate milestones, the level of decision for each milestone, and the documentation needed for each milestone. For this proposal, the size, complexity, and risk of the program are considered. The determinations made at program initiation are reexamined at each milestone in light of then-current program conditions.

5.1.1 Determining Mission Needs and Identifying Deficiencies

All acquisition programs are based on identified, documented, and validated mission needs. Mission needs result from ongoing assessments of current and projected capability. Mission needs may be designed to establish a new operational capability, improve an existing capability, or exploit an opportunity to reduce costs or enhance performance. First, DoD Components try to satisfy mission needs through nonmateriel solutions, such as changes in doctrine or tactics. If a nonmateriel solution is deemed not feasible, the Component documents its considerations and determines whether the potential materiel solution could result in an ACAT I or ACAT IA (see Hierarchy of Materiel alternatives in DoDD 5000.1). If the potential materiel solution could result in a new ACAT I, the Joint Requirements Oversight Council (JROC) reviews the documented mission need, determines its validity, and establishes joint potential. If the potential solution could result in a new ACAT IA, the appropriate OSD Principal Staff Assistant (PSA) or the JROC reviews the documented need, determines its validity, establishes joint potential, and confirms that the requirements defined in **DoDD 8000.1** have been met.

5.2 MISSION NEEDS STATEMENT AND LOGISTICS CONSTRAINTS

DoD Components document deficiencies in current capabilities and opportunities to provide new capabilities in a Mission Need Statement (MNS) expressed in broad operational terms. The MNS identifies and describes the mission deficiency; discusses the results of mission area analysis; describes why nonmateriel changes (i.e., doctrine, tactics, etc.) are not adequate to correct the deficiency; identifies potential materiel alternatives*; and describes any key boundary conditions and operational environments, such as logistics constraints, that may impact satisfying the need.* The MNS is prepared in accordance with CJCS MOP 77. System performance objectives and thresholds are developed from, and remain consistent with, the initial broad statements of operational capability. The requirements are refined at successive milestone decision points, as a consequence of cost-schedule-performance tradeoffs during each phase of the acquisition process.

In summary, all acquisition programs are based on identified, documented, and validated mission needs. Mission needs, which result from ongoing assessments of current and projected capability, may be designed to establish a new operational capability, improve an existing capability, or exploit an opportunity to reduce costs or enhance performance.

5.2.1 Cost Objectives

Upon approval of the MNS, an approach is formulated to set and refine cost objectives. Through consideration of projected out-year resources, recent unit costs, parametric estimates, mission effectiveness analysis and trades, and technology trends, each ACAT I and ACAT IA PM establishes life-cycle cost objectives for the program by program initiation (usually Milestone I).

5.2.2 Evaluation of Requirements Based on Commercial Market Potential

Researching the potential of the commercial marketplace to meet system performance requirements is an essential element of building a sound set of requirements. In developing system performance requirements, DoD Components evaluate how the desired performance requirements could reasonably be modified to facilitate the use of potential commercial items, components, specifications, standards, processes, technology, and sources. The results of the evaluation are included as part of the initial Operational Requirements Document (ORD).

5.3 OPERATIONAL REQUIREMENTS DOCUMENT

5.3.1 Operation Requirements Document (ORD)

At each milestone, beginning with program initiation (usually Milestone I), thresholds and objectives initially expressed as measures of effectiveness or performance and minimum acceptable requirements for the proposed concept or system are documented by the user or user's representative in an Operational Requirements Document (ORD). Thresholds

and objectives in the ORD consider the results of the analysis of alternatives and the impact of affordability constraints. Key Performance Parameters (KPPs), validated by the JROC, are included in the appropriate Acquisition Program Baseline (APB). A KPP is the capability or characteristic that is so significant that failure to meet the threshold can be cause for the concept or system selection to be reevaluated or the program to be reassessed or terminated. KPPs are extracted from the ORD and included in the APB. Thus, user or user representative participation in each acquisition phase is essential.

Thresholds and objectives are defined below. The values for an objective or threshold and definitions for any specific parameter contained in the ORD, TEMP, and APB shall be consistent.

5.3.1.1 Threshold. The threshold value is the minimally acceptable value that, in the user's judgment, is necessary to satisfy the need. If threshold values are not achieved, program performance is seriously degraded, the program may be too costly, or the program may no longer be timely. The spread between objective and threshold values is individually set for each program based on the characteristics of the program (e.g., maturity, risk, etc.).

5.3.1.2 Objective. The objective value is what the user desires and what the PM is attempting to obtain. The objective value could represent an operationally meaningful, time critical, and cost-effective increment above the threshold for each program parameter. Program objectives (parameters and values) may be refined based on the results of the preceding program phase(s).

5.3.2 Format for the Operational Requirements Document

Appendix II of DoD 5000.2-R provides a mandatory format for the ORD for use in ACAT I and IA programs as mandated by that regulation as well as CJCS MOP-77. The operational performance parameters in the initial ORD is tailored to the concept (e.g., satellite, aircraft, shop, missile, or weapon, etc.) and reflects system-level performance capabilities, such as range, probability of kill, platform survivability, operational availability, etc. Objectives should also be established for each parameter and shall represent a measurable, beneficial increment in operational capability or operations and *support*. Table 5A shows the logistics and readiness portion of the mandatory format. Note that all of the logistics (or support) elements are addressed in Chapter 7 of this document.

TABLE 5A

MANDATORY FORMAT: OPERATIONAL REQUIREMENTS DOCUMENT (ORD) — (LOGISTICS EXCERPTS)

4. Capabilities (Operational Performance Parameters) Required:
- Objectives, if stated, should represent a measurable, beneficial increase in capability or operations and support above the threshold.

4b. Logistics & Readiness:
- Operational Availability & Mission-Capable Rate Measures
- Frequency & Duration of Preventive or Scheduled Maintenance Actions
- Combat Support Requirements (expected maintenance levels, mobility, etc.)

5a. Maintenance Planning:
- Identify Maintenance tasks & time phasing for all maintenance levels
- Describe planning approach for contract vs. organic repair

5b. Support Equipment:
- Define Standard Support Equipment to be used by the system
- Describe test & fault isolation capabilities of Automated Test Equipment (ATE) at all levels

5c. Human Systems Integration:
- Establish broad manpower requirements for operators, maintainers, and support personnel
- Describe training concept (simulators, training device, embedded training, training logistics)

5d. Computer Resources:
- Describe the capabilities desired for integrated computer resources support.

5e. Other Logistics Considerations:
- Describe provisioning strategy
- Specify unique facility/shelter/environmental compliance requirements
- Identify special packaging/handling/transportation considerations
- Define unique data requirements

6
PROGRAM, LOGISTICS, AND RISK MANAGEMENT

Never too early to start logistics!
Cardinal rule

6.1 <u>POLICY</u>

6.1.1 Program Tailoring

All programs, including highly sensitive classified, cryptologic, and intelligence programs, shall accomplish certain core activities (described in DoDD 5000.1). These activities are tailored to minimize the time it takes to satisfy an identified need consistent with common sense and sound business practice. Some activities apply to Acquisition Category (ACAT I) programs only, not to ACAT II and III programs. Other important key activities for each phase will be applied on a program-by-program basis through the (Integrated Product Team) IPT process.

Tailoring gives full consideration to applicable statutes. Figure 6-1 depicts the major functions in the life-cycle acquisition process. The number of phases and decision points

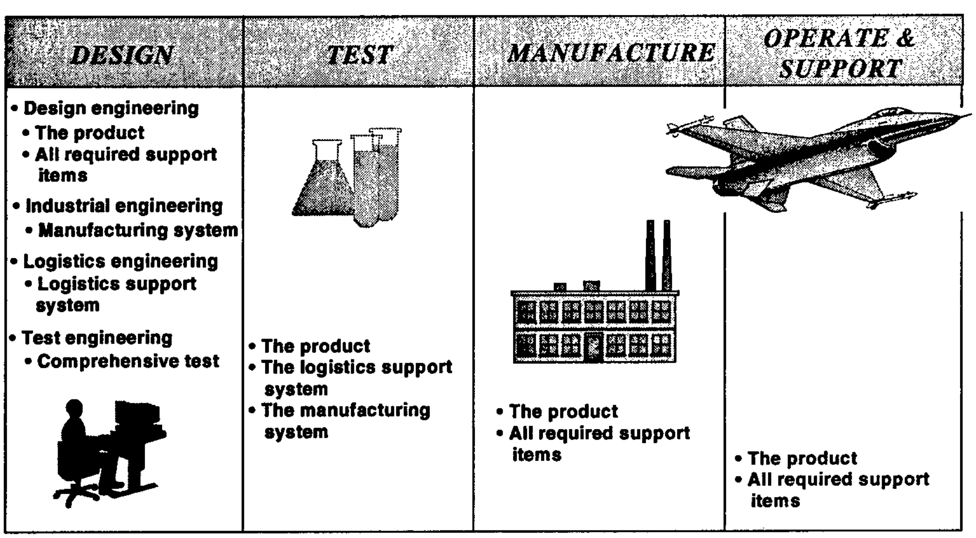


Figure 6-1: The Generic Life-Cycle Process

can be tailored to meet the specific needs of individual Program Managers (PMs) and their Milestone Decision Authority (MDA), based on objective assessments of a program's category status, risks, the adequacy of proposed risk management plans, and the urgency of the user's need. Tailored acquisition strategies may vary the way in which core activities are to be conducted, the formality of reviews and documentation, and the need for other supporting activities.

6.1.2 Determining Mission Needs and Identifying Deficiencies

Refer to Section 5.1.1 in the previous chapter.

6.1.3 Phase 0: Concept Exploration

Phase 0 typically consists of competitive, parallel, short-term concept studies. The focus of these efforts is to define and evaluate the feasibility of alternative concepts and to provide a basis for assessing the relative merits (i. e. advantages and disadvantages, degree of risk) of these concepts at the next milestone decision point. Analysis of alternatives shall be used as appropriate to facilitate comparisons of alternative concepts. The most promising system concepts shall be defined in terms of initial, broad objectives for cost, schedule, performance, software requirements, opportunities for tradeoffs, overall acquisition strategy, and test and evaluation strategy.

6.1.4 Phase I: Program Definition and Risk Reduction

During this phase, the program shall become defined as one or more concepts, design approaches, and/or parallel technologies that are pursued as warranted. Assessments of the advantages and disadvantages of alternative concepts shall be refined. Prototyping, demonstrations, and early operational assessments shall be considered and included as necessary to reduce risk so that technology, manufacturing, and support risks are well in hand before the next decision point. Cost drivers, life-cycle cost estimates, cost-performance trades, interoperability, and acquisition strategy alternatives are considered including evolutionary and incremental software development.

6.1.5 Phase II: Engineering and Manufacturing Development

The primary objectives of this phase are to translate the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing or production process; and demonstrate system capabilities through testing. Low Rate Initial Production (LRIP) occurs while the Engineering and Manufacturing Development (EMD) phase is still continuing as test results and design fixes or upgrades are incorporated.

6.1.6 Low Rate Initial Production[1]

The objective of this activity is to produce the minimum quantity necessary to provide:

- production-configured, or representative, articles for operational tests;
- an initial production base for the system; and
- an orderly increase in the system production rate that is sufficient to lead to full-rate production upon successful completion of operational testing.

LRIP quantities for all ACATs shall be minimized. The MDA shall determine the LRIP quantity (10 USC (24004)) for all Acquisition Category (ACAT) I and II programs as part of the Engineering and Manufacturing Development (EMD) approval. The LRIP quantity (with rationale for quantities exceeding 10 percent of the total production quantity documented in the acquisition strategy) is included in the first Selected Acquisition Report (SAR) after its determination. The LRIP quantity shall not be less than one unit, and any increase shall be approved by the MDA. When approved LRIP quantities are expected to be exceeded because the program has not yet demonstrated readiness to proceed to full-rate production, the MDA assesses the cost and benefits of a break in production versus annual buys.

Note: The Director, Operational Test and Evaluation (DOT&E), is the decision authority for the number of LRIP articles required for Initial Operational Test and Evaluation (IOT&E) and for Live Fire Test and Evaluation (LFT&E).

6.1.7 Phase III: Production, Fielding/Deployment, and Operational Support

The objective of the Production, Fielding/Deployment, and Operational Support phase is to achieve an operational capability that satisfies mission needs. Deficiencies encountered in Developmental Test and Evaluation (DT&E) and IOT&E are resolved and fixes verified. The production requirement of this phase does not apply to ACAT IA acquisition programs or software-intensive systems with no developmental hardware components. During fielding/deployment and throughout operational support, the potential for modifications to the fielded/deployed system continues.

6.1.7.1 Production. Chapter 24 of this guide is devoted to the subject of production and the logistics planning and testing associated with that phase.

6.1.7.2 Deployment/Fielding. The term "deployment," as used here, includes fielding, turnover, hand-off, fleet introduction, and other terms used by the Services for the initial introduction of a system to operational commands. Included are deployment planning,

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[1] LRIP is not applicable to ACAT IA programs; however, a limited deployment phase may be applicable.

execution, and follow-up requirements covering each of the logistics elements during the acquisition periods from Concept Exploration (CE) until the last unit is operational. Chapter 7 of this Guide is devoted to a description of the logistics element, and Chapter 25 is devoted to the subject of deployment/fielding.

6.1.8 Operational Support

The objectives of this activity are the execution of a support program that meets the threshold values of all support performance requirements and sustainment of them in the most cost-effective manner over the life cycle. A follow-on operational testing program that assesses performance, quality, compatibility, and interoperability and that identifies deficiencies shall be conducted as appropriate. This activity shall also include the execution of operational support plans, including the transition from contractor to organic support, if appropriate.

6.1.9 Modifications

Any modification that is of sufficient cost and complexity and that could itself qualify as an ACAT I or ACAT IA program is considered for management purposes as a separate acquisition effort. Modifications that do not cross the ACAT I or IA threshold are considered part of the program being modified. Modifications may cause a program baseline deviation. Deviations shall be reported using the procedures in Part 6 of DoD 5000.2-R.

6.1.10 Demilitarization and Disposal

At the end of its useful life, a system must be demilitarized, disposed, or recycled. During demilitarization and disposal, the PM ensures that materiel determined to require demilitarization is controlled and that disposal is carried out in a way that minimizes DoD's liability due to environmental, safety, security, and health issues.

6.2 PRODUCT DEFINITION

Product definition is the common thread linking all acquisition disciplines. In the current environment of near-full dependence on performance and commercial specifications, program management faces a significant challenge in making sure that the product is clearly defined, because of the following factors:

- Program planning must know *what* to plan for.
- System engineering and software must know *what* to design.
- The test community must know *what* to test.
- The producer must know *what* to manufacture.

- The logistics community must know *what* to support.

- Contract management must know *what* to buy.

- Cost management must know *what* to estimate and control.

- Funds management must know *what* to budget.

6.3 TIME-PHASED SUPPORT ACTIVITIES

Figure 6-2 displays the defense systems acquisition management process, showing the key management activities associated with each phase of the acquisition process. Correspondingly, the paragraphs immediately below (6.3.1 through 6.3.4) outline the major activities of the Logistics Manager (LM) up to and including the EMD program phase. Subsequent chapters of this guide provide information regarding activities associated with Production (Chapter 24), Fielding/Deployment (Chapter 25), Postproduction Support (Chapter 27), and Disposal/Recycling/Demilitarization (Chapter 29). Figure 6-3 displays the logistics management activities that take place within the larger defense systems acquisition management process displayed in Figure 6-2.

6.3.1 Prior To Milestone 0

Prior to Milestone 0, the major preprogram effort is the preparation of a Mission Needs Statement (MNS). The MNS should identify all logistics support constraints. In order to derive the constraints, the LM should investigate lessons learned and improvement targets on existing like and similar systems and equipment. Also, the LM should identify potential logistics technologies, perform early support analysis activities at the system level, and assess alternative acquisition logistics strategies. In summary, the functions to be performed prior to Milestone 0 are to:

- include logistics support constraints in the MNS;

- investigate lessons learned and improvement targets;

- identify potential logistics technologies;

- assess alternative acquisition logistics strategies; and

- perform early support analysis activities, such as developing a support concept.

ACQUISITION POLICY

	Nominal Time (In Years)	(0–2)	(2–4)	(4–7)	(12–79)
TITLE	**PRE-MILESTONE 0**	**PHASE 0 CONCEPT EXPLORATION (CE)**	**PHASE I PROGRAM DEFINITION & RISK REDUCTION (PDRR)**	**PHASE II ENGINEERING & MANUFACTURING DEVELOPMENT (EMD)**	**PHASE III PRODUCTION, FIELDING/DEPLOYMENT, & OPERATIONAL SUPPORT**
PURPOSE	• Mission Area Assessment • Identify Mission Needs That Cannot Be Satisfied by Nonmateriel Solutions • Prepare Mission Need Statement	• Evaluate Feasibility of Alternative Concepts • Determine Most Promising Concept(s)/Solution(s)	• Design System(s) • Demonstrate Critical Processes and Technologies (Early Prototypes)	• Mature and Finalize Selected Design • Validate Manufacturing & Production Processes • Test & Evaluate System	• Produce & Field/Deploy System • Monitor System Performance • Support Fielded System • Modify/Upgrade System As Required
DECISION POINTS	**MS 0** Approval to Conduct Concept Studies ▲ Approval of: • Conduct of Short-term Concept Studies • Phase 0 Exit Criteria	**MS I** Approval to Begin a New Acquisition Program ▲ Approval of: • Acquisition Strategy • Cost As an Independent Variable (CAIV) Objectives • Initial Acq Prog Baseline (APB) • Phase I Exit Criteria	**MS II** Approval to Enter Engineering & Manufacturing Development ▲ Approval of: • Acquisition Strategy • CAIV Objectives & Updated APB • LRIP Quantities • Phase II Exit Criteria	**MS III** Production or Fielding/Deployment Approval ▲ Approval of: • Acquisition Strategy • Production (Weapon System) or Deployment (Information System) • Updated APB • Phase III Exit Criteria	DEMILITARIZATION & DISPOSAL

Milestones and Phases Determined by MDA

Figure 6-2: The Defense Systems Acquisition Management Process

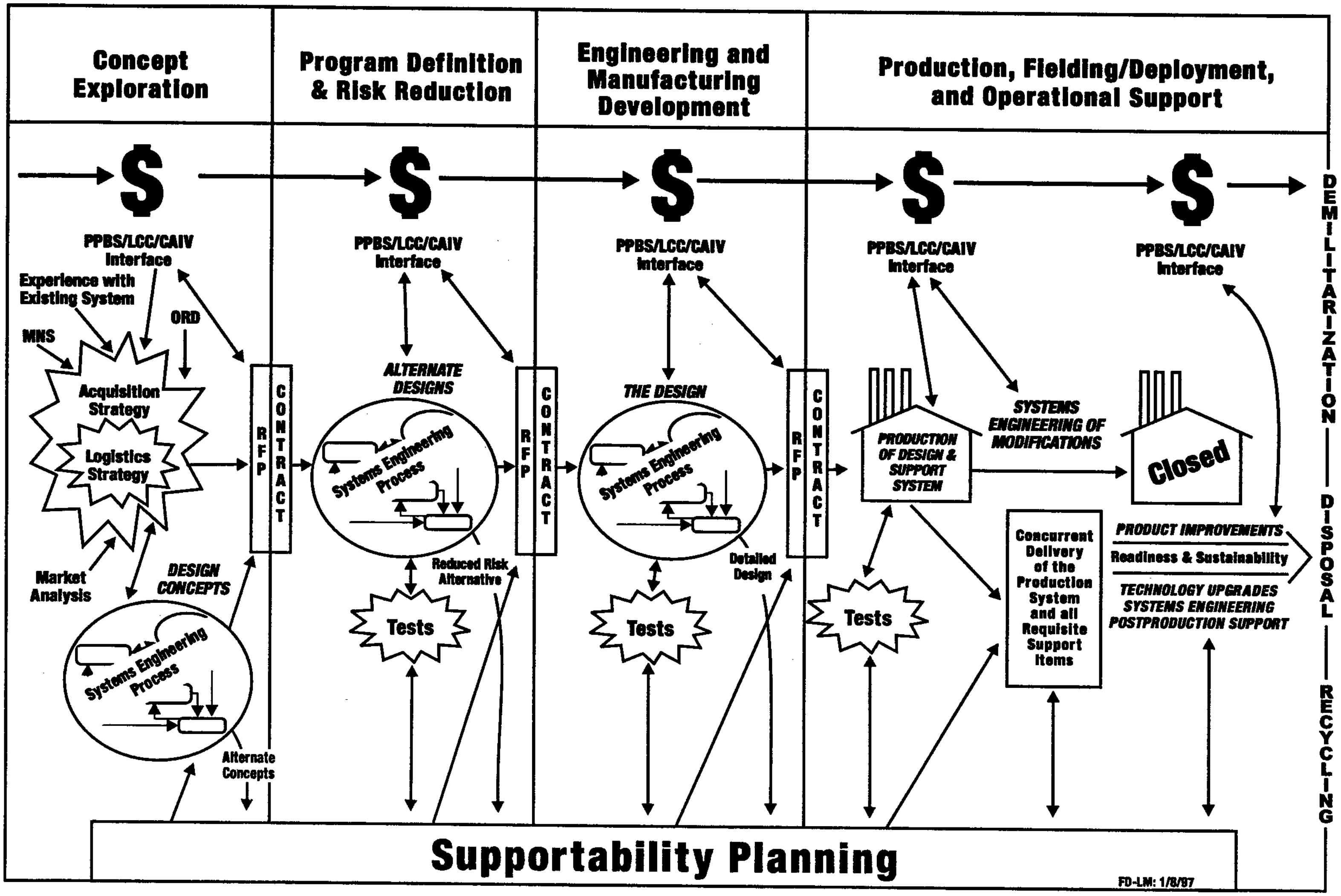


Figure 6-3: Acquisition Logistics Management Activities

6.3.2 Phase 0 – Concept Exploration

At this stage, no program or program office exists per se; but alternative concepts are being analyzed to satisfy the requirements of the MNS. A major planning effort is underway by a program office cadre to prepare for program initiation at Milestone I. The LM should:

- develop the acquisition logistics strategy;
- refine initial supportability planning and Life Cycle Cost (LCC) estimates;
- keep in step with emerging design;
- provide logistics involvement in PDRR contract management and Integrated Product Team (IPT) reviews;
- prepare logistics section of EMD contract package; and
- consider support analyses, such as Standardization and Interoperability.

6.3.3 Phase I – Program Definition and Risk Reduction

In this phase, principal program office activity centers on evaluating system alternatives; selecting preferred system alternative(s); defining the critical design characteristics and capabilities; and demonstrating that the required technologies can be incorporated into the system design. The LM will focus on the following tasks during this phase:

- implementing acquisition logistics strategy;
- refining initial supportability planning and LCC estimates;
- keeping in step with emerging design;
- providing logistics involvement in PDRR contract management and IPT reviews;
- preparing logistics section of EMD contract package;
- considering support analyses, such as standardization and interoperability; and
- initiating postproduction planning.

6.3.4 Phase II – Engineering and Manufacturing Development

The major activity of the PM is associated with translating the design approach into a stable, producible, and cost-effective system design and, through developmental and operational testing, demonstrating that the system meets specification requirements, satisfies the mission need, and meets minimally acceptable peacetime and wartime requirements. The main thrust of test programs is to evaluate system-level performance. However, the LM must build into the test program structure additional assessments of component evaluation and the adequacy of the logistics elements that comprise the logistics support structure. Further, the LM should work closely with the Program Management Office (PMO) and appropriate IPTs to accomplish the following:

- implement acquisition logistics strategy;
- continue to refine supportability planning and LCC estimates;
- commence Test and Evaluation (T&E) of logistics;
- continue logistics involvement in EMD contract management and IPT reviews;
- prepare the logistics sections of the Next-phase contract package; and
- consider support analyses, such as finalizing postproduction support plans.

6.4 RISK MANAGEMENT

Risk is inherent in any acquisition program and in virtually all functional areas of a program, *including the area of logistics*. The LM and other functional experts at all levels must address the areas of risk to ensure that program objectives are met. Risk management is a program management responsibility and is the act or practice of controlling risk drivers that adversely affect the program. It includes the process of identifying, analyzing, and tracking risk drivers; assessing the likelihood of their occurrence and their consequences; defining risk-handling plans; implementing these plans; and performing continuous assessments to determine how risks change during the life of the program. Risk management requires all process participants to use a disciplined approach so that an acceptable level of program risk is achieved and maintained. This is done by controlling the risks associated with the design, manufacturing, technology, test, and support functions that are part of systems acquisition.

A good risk management program can enhance program management effectiveness and provide managers with an important tool for reducing a system's life-cycle costs. A description of the risk management plan is an essential part of the program strategy. Effective risk management depends on a thorough understanding of the concept of risk, the principles of risk management, and the establishment of a disciplined risk management process. DoD policy does not mandate a specific approach to risk management. In the

past, aggressive performance requirements would drive technical, cost, and schedule risks. Under the Cost As an Independent Variable (CAIV) concept, the emphasis is reversed; and aggressive cost objectives can drive performance and schedule requirements and risks. Moreover, in coordination with the user, requirements may be reduced or eliminated so risk is reduced to a level that increases the likelihood of meeting cost objectives. By establishing an effective risk management program, PMs may design and control their programs by using information about risk areas to set objectives, develop acquisition strategies to mitigate risk, and identify metrics that allow continual tracking and assessment of the program. This process includes risk planning, assessing risk areas, developing risk-handling options, monitoring risks to determine how risks have changed, and documenting the overall risk management program.

6.4.1 Managing Support Risks

The Logistics Manager (LM) must focus on the support risk as well as risks associated with cost and schedule. Key support risks are those associated with:

- achieving reliability, availability, and maintainability goals;
- achieving an effective logistics support structure; and
- successfully deploying/fielding the system.

Cost and schedule risks are largely associated with the accuracy of the cost and schedule estimating processes and their supporting assumptions as well as risk associated with bottlenecking events or a high degree of concurrency. Both tend to create multiple critical paths in the work effort.

To effectively manage the pertinent risks, the LM must understand:

- what adverse events may occur;
- the likelihood (probability) of each event occurring; and
- the severity of the cost, schedule, and performance impacts of each event.

Given this level of understanding, the manager is in a position to seek ways to do one or more of the following:

- make it less likely that the risk event will occur;
- deal with the cost, schedule, and performance effects of the risk event in ways that minimize damage to the program; and/or

- decide to accept the risk as reasonable given the cost, schedule, and performance advantages of the acquisition strategy and the program's requirements.

6.4.2 Risk Management in CAIV

The following list provides key areas of risk that must be addressed in a "formal risk" effort within a program as a part of the CAIV process. Such a risk effort must have dedicated program office assigned resources in order to implement CAIV. Some of these risks are in conflict with others and a continual balancing of these risks is required. Bad news should be allowed to surface; the manager should always know the worst thing that can happen to the program. The process, as noted earlier, is an iterative one; and the risks come into play multiple times during the life of the program. Risks to watch:

- The program is broken into manageable elements. The attention to costs required by CAIV makes it essential that the government PM has manageable elements for the entire program. These elements must have metrics so the accompanying risks can be measured, assessed, and managed for each element and the entire program.

- To provide realistic system affordability, the current budget and priority decisions for a system are sufficiently accurate and remain stable over the program life cycle. The program budget must be realistic and stable for a successful program. This is a major problem in managing most acquisition programs. It is even more critical under CAIV, where cost explicitly drives performance and schedule. *Keep cost off the critical path through daily management by key individuals.*

- The threshold performance requirements will provide the necessary mission effectiveness and will be stable during system development and production. Risks are the differences between threshold and objective requirements that provide sufficient tradeoffs between cost, schedule, and performance. The balance between ensuring that the system will meet the users true requirements and the necessity that the threshold requirement will be sufficiently low that real trade space exists between the threshold and objective is critical to the tradeoff process.

- The shape of the function relating performance, schedule, requirement(s), mission effectiveness, and cost can be determined and subsequently utilized in tradeoff analyses. The determination of this function and the desire to find the "knee of the curve" will require not only good cost data but also extensive modeling of mission effectiveness. An excellent example is the work of the F-22 Aircraft Program in modeling these relationships.

- The historical database for parametric estimates used in cost-effectiveness assessment is sufficiently applicable to the system being estimated to provide an

accurate, most likely value and range (or probability distribution function) for the costs of the system. The database for parametric estimates seems to be always populated with programs that are sufficiently different in technology, design, or mission from the program that the validity of the estimate is in question. Further, there is almost no data linked to acquisition reform that reflects the cost savings within both government and industry. For good tradeoffs to be possible, good cost models, with valid data reflecting the current cost initiatives, must be available. The Under Secretary of Defense for Acquisition and Technology (USD(A&T)) has pointed out that much work remains to be done in the area of cost modeling in support of CAIV.

- The interrelationships of the system performance requirements are sufficiently understood to select the most cost-effective system performance objectives. Performance requirements and schedule must be accurately translated into contractual goals the contractor has sufficient incentive to achieve. System performance goals are seldom independent. The schedule can be linked to cost and mission. Understanding these interrelationships is critical to contracting with, and giving incentive to, the contractor.

- Technology developments will enable specific design and process decisions to be achieved. If the performance requirements have been too ambitious and they do not become achievable, the cost and schedule of technology development will become the drivers.

The central feature of CAIV is the tradeoff process. This process of determining affordable performance and scheduling based on cost goals is accomplished by a set of decisions that balance the above risks.

6.4.3 Risk Management in Joint Programs

In many ways, program management is risk management; and joint programs add to the number of risks facing the joint PM. By definition, the joint PM has multiple users, requirements and funding sources. These customers can adversely affect the health of the program by raising issues related to system requirements, funding variations, or political nuances within the program. A common issue is the degree and effectiveness of interoperability of the new system with participating Component systems. Accordingly, the joint PM should be careful to monitor technical risks in order to help maintain program consensus and ensure proper interoperability.

6.4.3.1 Logistics Risk Areas in Joint Programs. Logistics planning for joint programs requires more coordination than that required for single-Service programs. No other aspect of joint program management will confront the manager with as many inter-Service differences as logistics. Differences can occur in all of the logistics elements. The lack of extensive coordination can lead to:

- incomplete or inadequate logistics support at the time of initial deployment;

- a decision by one or more Services to go it alone with logistics planning and development of Service-unique logistics support; and

- loss of the economies that can be gained by joint-logistics performance.

6.4.3.2 Risk Handling. Success in joint program management comes from facilitating and expediting the required coordination, not from eliminating coordination and fragmenting the program. Methods that have been employed include:

- Early Recognition of Joint Requirements. During mission area analysis, a vital first step is early recognition that a joint program is needed. OSD, the Joint Chiefs of Staff (JCS), or two or more Services in unison may initiate the joint MNS. When this occurs, a joint program structure is recommended in the MNS; funding requirements for each Service are identified in each Service's initial Program Objectives Memorandum; and common and unique requirements of the Services are documented in the initial joint Logistics Plan prepared during CE.

- Staffing of the Joint Program Office. Senior representatives and other participating Service personnel serve two vital functions. First, they work as part of a team committed to objectives of the joint program. Second, they are conduits for rapid two-way communications and decisions on methods to implement joint planning and satisfy unique needs of each Service.

- Effective Communication. Implementation of joint logistics planning by the Services requires participation by their subordinate activities. Effective communications must be carried out among the provisioners, maintenance engineers, publication managers, trainers, and other logisticians who support the program within the Services. The lead LM must ensure that key logistics personnel from each Service are identified and that they jointly participate in planning and establishing the program. A hierarchy consisting of a high-level review team, a joint logistics committee, and functional working groups may be established to provide oversight and rapid decisions that meet each Service's needs.

- Incremental Development Techniques. Preplanned Product Improvement provisions, evolutionary development, and other incremental development techniques, especially if coordinated with user commands, can split development problems into small increments and defer large risks. The use of standard software and software reuse can also minimize software and program development risks. The Logistics IPT must closely monitor the program cost/design/performance tradeoffs to evaluate the logistics impacts on each of the Component support programs.

6.4.4 Reference

For more information regarding risk management tools and techniques, the reader is referred to the Teaching Note entitled, "Program Risk Management," by W. W. Bahnmaier and Paul McMahon, Defense Systems Management College, Oct. 8, 1996.

7

SUPPORT ELEMENTS

"I don't know what the hell this "logistics" is that [General] Marshall is talking about, but I want some of it."

Admiral Ernest J. King,
during World War II

7.1 BACKGROUND

The DSMC's *Glossary of Defense Acquisition Acronyms and Terms* (May 1997), defines acquisition logistics as technical and management activities that ensure supportability implications are considered early and throughout the acquisition process to minimize support costs and that provide the user with the resources to sustain the system in the field.

One of the best management techniques for addressing all aspects of logistics is to use a "checklist" of logistics elements (sometimes called "support elements"). Figure 7-1 depicts the ten logistics support elements. Addressing each of these elements is the surest way to identify the supportability implications of your system. The following traditional logistics elements constitute the support infrastructure that should be addressed (including both hardware and software considerations) over the system life cycle under both peacetime and wartime conditions.

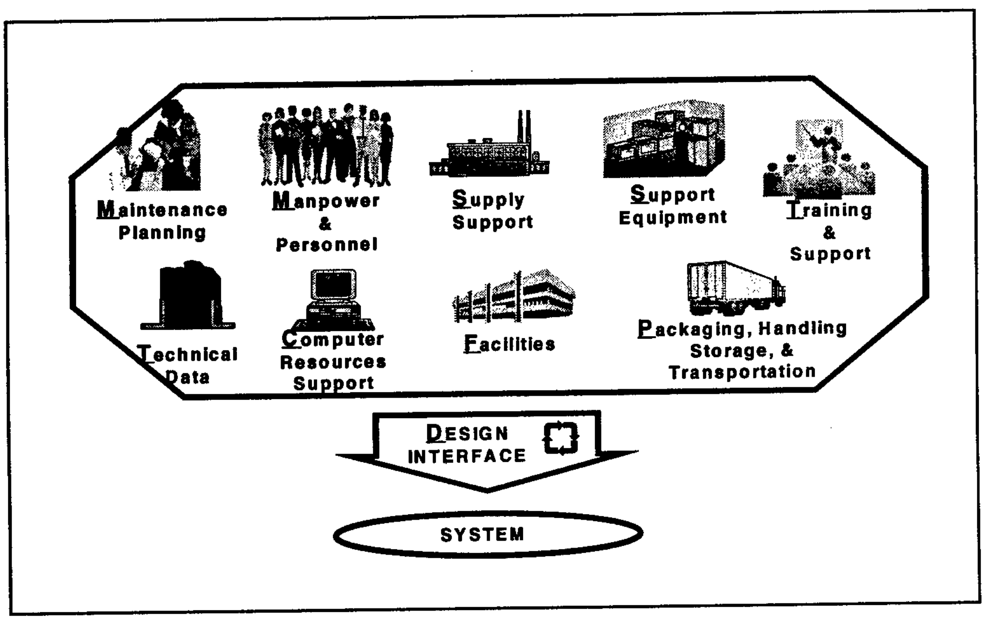


Figure 7-1: The Logistics Elements

Before addressing each of the logistics elements in turn, a word of caution is in order. The DoD movement toward the use of commercial specifications, best practices, and performance specifications demands that support requirements, as stated in formal program documentation, be addressed *in terms of program performance specifications* as opposed to addressing distinct logistics elements. Specifically, the support requirements should relate to a system's operational effectiveness, operational suitability, and life-cycle cost reduction. This approach is specified in Section 2.6 of DoD 5000.2-R. Therefore, the tradeoffs involved in the early phases of design development must consider logistics elements and system design elements in a closely integrated fashion in order to achieve the overall system goals.

7.2 MAINTENANCE PLANNING

Maintenance planning is the process conducted to develop and establish maintenance and support concepts and requirements for the lifetime of the defense system. It answers questions such as the following: What can go wrong? Who will fix it? Where will it be fixed? How will it be fixed? When will it be fixed? An acquisition program should establish logistics support/maintenance plans throughout the development process, with life-cycle costs playing a key role in this process. Support/maintenance concepts should reflect the optimum balance between readiness and life-cycle cost. Maintenance planning is the logical starting point in addressing the logistics elements. If the maintenance plan changes, chances are that many of the other logistics elements will also change. Traditionally, there have been three levels of maintenance, i.e., organizational, intermediate, and depot; however, some systems or subsystems operate with two levels of maintenance, omitting the intermediate level. Table 7A characterizes the activities performed at each of the three maintenance levels.

Table 7A
TRADITIONAL LEVELS OF MAINTENANCE

I ORGANIZATIONAL	II INTERMEDIATE*	III DEPOT
• On equipment/system • Quick turnaround • Repair by replacement (LRA/WRA)	• Between org. and depot • Repair by replacement of shop replaceable units or components	• Overhaul/complex repair • System and functional responsibility • Production line orientation • Supply system support

*For Army "intermediate," includes Direct Support (DS) and General Support (GS):

- DS -	- GS -
Repair by replacement	Repair down to the component level
Corps level	Echelon above corps
High mobility	Semi-fixed facilities
Supports unit supply	Supports theater supply systems

7.2.1 Maintenance Concept

A maintenance concept is a general description of the maintenance tasks required in support of a given system or equipment and the designation of the maintenance level for performing each task. The maintenance concept will normally be incorporated into the more specific maintenance plan.

7.2.2 Maintenance Plan

A maintenance plan is a description of the requirements and tasks to be accomplished for achieving, restoring, or maintaining the operational capability of a system, equipment, or facility. The maintenance plan is normally one of the parts of the logistics support plan.

The irreversible and increasing commitment of DoD to Automated Information Systems (AIS) and subsystems requires maintenance concepts/plans to address both hardware and software, in order to ensure an integrated approach. However, the nature of hardware maintenance differs from that of software maintenance. When hardware fails, the failure is usually isolated to a faulty part, which can be removed and replaced. A paper description (failure report) and a faulty part are available for inspection or further analysis by the hardware depot. When software fails, only a paper description (software trouble report) is normally available for inspection and further analysis. Faced with a software failure, the operator (who can be thought of as the organizational level of software maintenance) will usually attempt a system restart or some other type of workaround. The programming support center (which can be thought of as the software maintenance depot) must duplicate the software failure on its own equipment before commencing the process of "fixing" the failure.

Hardware maintenance is relatively straightforward. When it fails, the failure is detected, a bad part is isolated, and the bad part is replaced with a good part. Software maintenance, on the other hand, is not so straightforward. If it fails, the software must be redesigned to preclude a similar failure. The rest of the system may also have to be checked to assure that fixing the failure at hand does not introduce other errors or potentials for failure into the system. A more thorough discussion of software logistics considerations is contained in Chapter 20 of this Guide.

A significant danger in software maintenance arises from the fact that product improvements and redesign are accomplished through exactly the same procedure as failure repairs. Because of programmers' natural tendency to "fine tune" their systems at every stage and occasionally add more sophistication (without thought of cost or schedule), a single error fix or repair frequently becomes an opportunity for much more elaborate software engineering. This tendency must be carefully controlled. Figure 7-2 diagrams a typical maintenance concept, which includes both hardware and software.

Some of the necessary issues in the first round of maintenance planning: Are organic support, contractor support, or a combination of the two called for? If contractor support is

used, will it be life-cycle prime contractor support or competition? Can a prime contractor hardware and software warranty be instituted? What happens if the operator, upon occurrence of a hardware or software failure, is unable to work around the problem? Is there a manual backup? If not, are hardware and software specialists available on-call? It is important to remember that both hardware and software must be addressed at the same time to achieve a truly integrated maintenance plan.

For software in particular, the development of a life-cycle management plan, with emphasis on the planning for transition to the support phase, is of paramount importance, since the majority of the cost of software (60 to 80 percent) is associated with post-production support.

7.2.3 Manpower and Personnel

Manpower and personnel is the term used to represent the people required to operate and support the system (including its support) over its planned life cycle. Manpower and personnel analysis is the process conducted to identify and acquire military and civilian personnel with the skills and grades required to operate and support the system over its planned lifetime at both peacetime and wartime rates. Acquisition logistics efforts should strive to minimize the quantity and skill levels of manpower and personnel required to operate and support the system, since manpower and personnel can be expected to be a major, if not the major, contributor to system life-cycle cost. Manpower and personnel certainly continue to constitute the largest component of the DoD budget.

Skill levels of Service personnel and turnover continue to be significant problems. To cope with this, DoD has been forced to greatly simplify man/machine interfaces and utilize built-in test/fault isolation devices to reduce, at least at the organizational level of maintenance, the skill levels required of personnel who operate and maintain the systems. This approach has resulted in more complex and costly automated information systems and subsystems. Highly skilled individuals (college graduates entering the Service, motivated individuals who can be trained, etc.) are generally required to maintain the increasingly sophisticated types of software. This trend toward more information technology (IT) continues unabated.

The unique characteristics and skills of individuals available now, and projected into the future, to operate and maintain AIS at all levels must influence basic design decisions. Allocation of functions to hardware and to software must be logically made to ensure compatibility between the required and available individuals. The decision regarding organic versus contractor support of AIS must be made early in the program, and efforts must be made to garner the required core software logisticians for the program.

7.2.4 Supply Support

Supply support analysis is the process conducted to determine, acquire, catalog, receive, store, transfer, issue, and dispose of secondary items necessary for the support of end items and support items (such as support and test equipment, trainers, and simulators) that meet the user's peacetime and wartime readiness requirements. The process includes initial support (provisioning) and follow-on requirements (routine replenishment). Acquisition logistics efforts should strive to reduce the variety of parts and maximize the standardization of parts used in end items and support items.

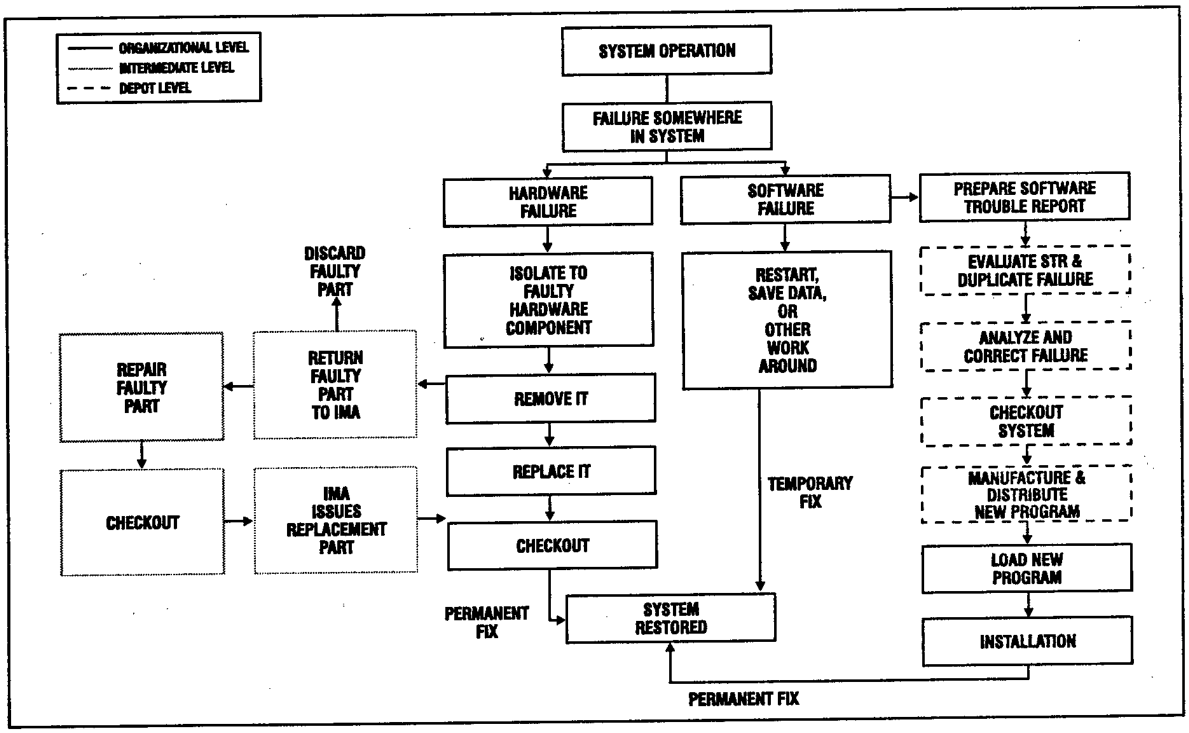


Figure 7-2: Typical Hardware/Software Maintenance Concept

Supply support involves ensuring that spares (hardware components and computer programs) and repair parts required to operate and maintain a system are provided on a timely basis. Consumable or expendable items, such as computer printer paper, batteries, and printer ribbons, are also included here. Hardware supply support consists of a provisioning phase followed by routine replenishment. Software supply support must include software and firmware cataloging and provision for, and routine resupply of, media (printer paper, cards, magnetic and paper tapes, etc.) used to transfer or transport computer programs.

Standardization of hardware components, devices, and systems and their selection for use in new designs can go a long way toward reducing the costs of new designs and the costs and complexity of supply support. Software standardization is of equal importance.

Transportability of software among a variety of existing and future IT systems is an important issue.

When hardware fails, an already designed replacement is drawn from stock or backordered. When software fails, it is necessary to redesign the software and then manufacture and distribute copies; only after these functions are done can a replacement program be provided to correct the failure condition. Hence, computer program resupply can rarely be as responsive as hardware resupply. Issues of software licensing, con-figuration management, and software reuse must be addressed.

7.2.5 Support and Test Equipment

Support and test equipment is the term applied to all equipment (mobile or fixed) required to support the operation and maintenance of the defense system, including ground handling equipment, tools, metrology/calibration equipment, manual/automatic test equipment, and other single-/multi-use support items. Acquisition logistics efforts should strive to reduce or eliminate the number of tools and support equipment required to maintain the defense system. If tools and/or support equipment are shown to be absolutely needed, standardization should be considered. The introduction of unique types of Automatic Test Systems (ATS) into the DoD field, depot, and manufacturing operations should be minimized. The use of commercial testers and components should be encouraged, by considering Automated Test Equipment (ATE) hardware and software requirements that can be met by using DoD ATS families or commercial testers along with critical architecture elements and interfaces.

Ideally, system-level troubleshooting techniques for a modern, software-intensive system will include performance monitoring/fault isolation capability (on-line maintenance and diagnostic programs) with some foundation in software. This will aid the user in initially recognizing a failure and distinguishing (at the systems level) between a hardware and software failure. An integrated hardware-software support facility can greatly aid in system supportability. Generally, hardware failures are further isolated by either a built-in test (with its associated software in more modern systems), external automatic test equipment (also with its software programs), or manual test equipment such as voltmeters or oscilloscopes). Software failure is further isolated by means of the support software. This can be either built into the operational software (as in self-healing software) or externally applied in conjunction with the operational software (using module test tools, debugging routines, or off-line diagnostic routines).

7.2.6 Technical Data

Technical data is scientific or technical information (recorded in any form or medium) necessary to operate and/or maintain the defense system. Acquisition logistics efforts should strive to optimize the quantity, format, and interchangeability of technical data. Data requirements should be consistent with the planned support concept and represent the minimum essential to effectively support the fielded system. Government requirements for

contractor-developed support data should be coordinated with the data requirements of other program functional specialties to minimize data redundancies and inconsistencies. The program office should ensure compatibility with existing internal government information processing systems. However, maximum use should be made of available contractor data systems and data formats when they can readily satisfy program needs.

Demanding unlimited government data rights or delivering truckloads of technical publications does not always solve technical data problems. Careful selection of hardware and software documentation approaches and techniques is essential. The quantity of data procured and its associated quality must also be considered. Currency and accuracy of delivered data are also important. Managers must be meticulous in selecting the items of documentation required to support a modern, software-intensive system.

Language is also an important consideration. For years, English has been the common language in the hardware world; however, English language vocabulary in the software world has not yet matured into a standard set of words and meanings. The available number of different programming Higher Order Languages (HOL), e.g., CMS-2, JOVIAL, COBOL, FORTRAN, Ada, ATLAS, etc., creates a challenge in selection. Necessity for assuring language standardization and control is a significant software supportability consideration. A CALS interface between the contractor and the government activities is needed for expeditious technical data transfer.

7.2.7 Training and Training Support

Training and training support includes the processes, procedures, curricula, techniques, training devices, simulators, and other equipment necessary to train civilian and active duty/reserve duty personnel to operate and support/maintain the defense system. This includes individual and crew training (both initial training and follow-on training); new equipment training; and initial, formal, and on-the-job training. In addition to the defense system, logistics support planning normally includes acquisition, installation, operation, and support of training equipment/devices. Acquisition logistics efforts should strive to minimize the training and training support required to effectively operate and support the defense system.

Computer-aided instruction offers considerable economy and great promise. Self-paced instruction is also proving to be an efficient learning tool and is gaining greater acceptance among the Services every day. Both types of instruction, however, usually require IT devices, consisting of both hardware and software, which must be supported. Simulators and trainers that simulate the operational system have been used in the past and are increasing in sophistication, effectiveness, and affordability. The more modern of these devices include both hardware and software. Embedded training (trainers that utilize the operational hardware loaded with a training program in order to function as a training device) is another approach offering great cost-effectiveness for the future.

Operator and maintenance training for software-intensive systems must be provided in a timely manner to support planned introduction rates of these systems. This effort must include instruction in both hardware and software, depending on the purpose of the training and operational system itself. The differences between hardware maintenance and software support require an entirely different training track for each and recognition that the software logistician must be a skilled computer programmer.

Before training begins, an overall training plan is usually prepared, including instruction in formal schools, informal on-the-job training, and required adjustments to existing training in related areas. Instruction in system operation, organizational-level maintenance, intermediate-level maintenance, and depot-level maintenance is normally provided. Hardware and software are addressed at each level to the degree dictated by the operational and maintenance concepts. New material introducing team training, instructor training, and refresher training must also be developed.

Courses of instruction also require planned student selection criteria, prerequisites, course capacity, lesson plans, scheduling, and course materials. Other required resources may include trainers, simulators, additional systems dedicated to training, and training software development.

7.2.8 Facilities

Facilities include the permanent, semi-permanent, or temporary real property assets required to operate and support the system. The facilities analysis includes conducting studies to define necessary facilities or facility improvements and determining locations, space, utilities, environmental, real estate, and equipment needs. Acquisition logistics efforts should strive to minimize or eliminate the facilities required to operate and support the defense system. Where facilities are demonstrated to be absolutely needed, maximizing the use of existing facilities should be considered.

Hardware maintenance facilities can be generally broken down into organizational, intermediate, depot-level, or other special levels (such as four or five levels of maintenance). Buildings, special power, clean rooms, anechoic chambers, shielded cages, space for support and test equipment, offices, and the like, fall into this category. Software facilities can be generally thought of in terms of organizational and depot-level maintenance facilities (programming support centers). Buildings, special power, special equipment cooling, equipment spaces, tape library, and offices are in this category.

The locations of hardware and software maintenance facilities bear careful consideration in terms of cost, responsiveness, efficiency, and other factors. Co-location of both facilities may result in better efficiency and responsiveness but must be balanced with the economies inherent in depot inter-servicing. Existing facilities or existing facility modifications must, likewise, be carefully evaluated before decision to construct new facilities.

The equipment required to develop and produce hardware (such as an assembly line) has tended, in the past, to be different from the equipment required to maintain hardware. Items required to develop and produce software are usually identical to the tools required to maintain software. The following components comprise the programming support center:

- software development laboratory;
- hardware integration laboratory; and
- a test system (for final checkout).

7.2.9 Packaging, Handling, Storage, and Transportation

Packaging, Handling, Storage, and Transportation (PHS&T) includes the resources, processes, procedures, design considerations, and methods to ensure that the defense system, equipment, and support items are packaged/preserved, handled, stored, and transported properly. The related analysis includes determination of environmental considerations, preservation requirement for short- and long-term storage, transportability requirements, and other methods to ensure elimination/minimization of damage to the defense system and its necessary support infrastructure. Acquisition logistics efforts should strive to minimize or eliminate undue/unnecessary packaging, handling, storage, and transportation requirements for the operation and maintenance of the defense system.

Containers, forklift trucks, cargo aircraft, warehouses, commercial transport, security, packing materials, paperwork, transport schedules, preservation, cargo ships, dock workers, pipelines, and a host of similar factors characterize PHST. Key emphasis is on the avoidance of damage or deterioration in safe and timely movement and storage of systems.

PHST is generally more of a problem for hardware than software. Hardware is usually large and bulky, whereas software may be contained in a single reel of magnetic tape. Hardware damage in transport or handing is usually repaired; software damage is usually attributable to the media conveying the software program or to alteration of the state of information in the media and is repaired by reissuing or duplication the program using new media.

Extended storage can pose a problem for volatile computer memories whose contents may be lost or altered. Hardware can be expected to deteriorate with age. Although software does not wear out, its media does. Software also tends to become obsolete very quickly because of rapid advances in the state-of-the-art.

7.2.10 Computer Resources Support

Proper, comprehensive, and careful attention to the hardware and software implications of each of the aforementioned logistics elements and support infrastructure should reduce or eliminate the need to separately address any remaining issues regarding:

- facilities;
- hardware;
- software (system software and support software);
- documentation;
- personnel; or
- other resources necessary to operate and support computer systems and software-intensive systems.

Acquisition logistics efforts should strive to ensure that computer resources support is established in a cost-effective and timely manner for the growing number of software intensive defense systems.

The optimum maintenance concept cannot be selected without inclusion of both hardware and software considerations. Likewise, tradeoffs among all the logistics elements must include both the hardware and software implications within each logistics element. Table 7B lists the more prominent implications. To trade off the hardware implication of all logistics elements against the software implications of only one logistics element will not facilitate support system optimization in a modern software-intensive system.

It is virtually impossible to design a modern, military system without a computer and the software accompanying it. This poses a greater challenge for the future. The solution lies in superior perspective and sound, integrated management at all levels of both government and industry.

7.2.11 Design Interface

Design interface will remain the primary area of the integration among the logistics and systems/software engineering functions. However, the interface area must be extended beyond design in order to ensure program success. A smooth, seamless interface between logistics and all other related disciplines (such as systems and software engineering, test and evaluation, manufacturing, life-cycle cost and financial resources) is essential to overall program success. Use of Integrated Product Teams (IPTs), with logistics representation, is the preferred method to achieve this result during all phases of the defense systems acquisition management process.

TABLE 7B
HARDWARE VERSUS COMPUTER RESOURCES SUPPORT

	HARDWARE	SOFTWARE
THE MAINTENANCE PLAN	3-LEVEL FAILED PART AND PAPER REPAIR	2-LEVEL PAPER PROBLEM DESCRIPTION ONLY MODIFICATION
MANPOWER AND PERSONNEL	AVERAGE LOWER SKILL LEVELS RELATIVE ADEQUACY OF NUMBERS RETENTION RATES – AVERAGE	AVERAGE HIGHER SKILL LEVELS RELATIVE SHORTAGE OF NUMBERS RETENTION RATES – A PROBLEM
SUPPORT AND TEST EQUIPMENT	SYSTEM LEVEL PERFORMANCE MONITORING/FAULT ISOLATION BUILT-IN TEST (EXTERNAL) AUTOMATIC TEST EQUIPMENT TEST EQUIPMENT	ON-LINE MAINTENANCE AND DIAGNOSTIC PROGRAMS BUILT-IN TEST SOFTWARE AUTOMATIC TEST EQUIPMENT SOFTWARE SUPPORT SOFTWARE
TRAINING AND TRAINING SUPPORT	SYSTEM HARDWARE OPERATION HARDWARE MAINTENANCE TRAINING COMPUTER-AIDED INSTRUCTION TRAINER/SIMULATOR	SYSTEM SOFTWARE OPERATION SOFTWARE MAINTENANCE TRAINING COMPUTER-AIDED INSTRUCTION SOFTWARE TRAINING DEVICE SOFTWARE
SUPPLY SUPPORT	PROVISION AND RESUPPLY ALREADY DESIGNED ITEMS RESUPPLY HARDWARE USE EXISTING PARTS/MODULES/ END ITEMS TO MAX EXTENT POSSIBLE	MODIFY THE SOFTWARE AND THEN SUPPLY IT RESUPPLY TRANSFER MEDIA USE EXISTING PROGRAMS/COMPUTER- PROGRAM COMPONENTS TO MAXIMUM EXTENT FEASIBLE
TECHNICAL DATA	ENGLISH LANGUAGE HARDWARE DOCUMENTA- TION CONVENTIONS TECHNICAL PUBLICATIONS	HIGHER ORDER LANGUAGE SOFTWARE DOCUMENTA- TION CONVENTIONS PROGRAM DOCUMENTATION
PACKAGING, HANDLING, TRANSPORTATION AND STORAGE	AVOID DAMAGE/DETERIORATION IN SYSTEM MOVEMENT – REPAIR IF DAMAGED HARDWARE WEAROUT	CONVEY PROGRAM UPDATES TO UNITS – REPLACE WITH ANOTHER COPY IF DAMAGED OR ALTERED SOFTWARE DOES NOT WEAR OUT – ITS MEDIA DOES
FACILITIES	ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE FACILITIES PRODUCTION-LINE AND MAINTENANCE FACILITIES DIFFERENT	ORGANIZATIONAL AND DEPOT MAINTENANCE FACILITIES PRODUCTION-LINE AND MAINTENANCE FACILITIES IDENTICAL

7.2.12 Other

Additional areas that may be considered by the IPT include: Reliability, Availability, and Maintainability (RAM); Life-Cycle Cost (LCC); Logistics Support Resource Funding; etc. These additional areas are important functional elements of program success. In the past, some of these were included at various times as logistics elements.

7.2.13 Tailoring

With no official identification or definitions of the logistics elements in DoDD 5000.1 or DoD 5000.2-R, IPTs are free to "tailor" the logistics elements to best suit the specifics of their programs.

7.2.14 Logistics Elements and Associated Software Issues

Table 7C lists the logistics elements and provides associated software issues under each element. The major issues were addressed earlier in this Chapter; hence the list is somewhat redundant. However, these issues were interspersed with hardware considerations; and other issues shown in the Table were not addressed. The table is intended to serve as a software "checklist" and to emphasize software considerations rather than the older, better-known (or longer-standing) hardware considerations.

TABLE 7C
LOGISTICS ELEMENTS AND ASSOCIATED SOFTWARE ISSUES

MAINTENANCE PLANNING
- Software Maintenance Concept
- Software Life-Cycle Support Plan
- Pre-Planned Product Improvement
- Source, Maintainability, Recoverability Coding
- Contractor versus In-house Support
- Transition Plan

MANPOWER/PERSONNEL
- Contractor versus In-house
- Military versus Civilian
- Mix versus Enhanced Profile
- Core Software Logisticians
- Skill Mix

SUPPLY SUPPORT
- Communication Transfer Media
- Inventory Management
- Configuration Management
- Software and Firmware Cataloging
- Software Re-use
- Storage
- Security
- Licensing

SUPPORT EQUIPMENT
- Computer-Aided Software Engineering (CASE) Tools
- Integrated Support Facility
- Depot versus Field
- Simulation/Simulators
- Actual Hardware

TECHNICAL DATA
- Specifications/Documentation
- CALS Interface for Technical Data Transfer
- Regulation Conflicts (Tech Order Data)
- Failure Reporting

TABLE 7C (Continued)
LOGISTICS ELEMENTS AND ASSOCIATED SOFTWARE ISSUES

TRAINING

- System Operations
- Software Logistics
- Simulators/Trainers
- Computer-Based Training Media
- Human Factors
- Failure Reporting

COMPUTER RESOURCES SUPPORT

- Integrated Support Facilities
- Support Environment
- Security Partitioning
- Computer Resources Logistics Support Planning/Documentation
- Support Software

FACILITIES

- In-house versus Contractor
- Operational Location versus Depot
- Foreign Military Sales Support
- Security & TEMPEST Space Planning
- Communications
- Human Factors
- Backup and Disaster Recovery Provisions

DESIGN INTERFACE

- Capacity – Memory/Throughput
- Reliability/Maintainability/Safety
- Support Level: Field versus Depot
- Support: In-house versus Contractor
- Firmware Interfaces
- Life-Cycle Costing
- Commercial Items
- Security
- Re-use

8

SYSTEMS ENGINEERING AND SUPPORTABILITY ANALYSES

The success of a logistics program hinges on how the readiness and supportability characteristics are designed into the system.

Key concept

8.1 INTRODUCTION

The purpose of this chapter is to address the role of logistics as an element in the Systems Engineering (SE) process. Only selected highlights of the SE process, i.e., those that clarify the linkage between logistics and SE, are presented herein.

The SE process is used to translate operational needs and requirements into a system solution that includes the design, manufacturing, test and evaluation, and support processes and products. A major goal of SE is the achievement of a proper balance among performance (including readiness and supportability), risk, cost, and schedule. This goal is sought by employing the following top-down iterative steps that define the SE process: requirements analysis, functional analysis and allocation, design synthesis and verification, and system analysis and control.

The readiness and supportability characteristics of a system must be included in the design in during the early phases, i.e., Concept Exploration (CE) and Program Definition and Risk Reduction (PDRR), while the system design is in its formative stages and tradeoffs are most easily accomplished. Thereafter, these characteristics must be reevaluated continually through the life of the program, considering, among other things, the opportunity for technology insertion to enhance readiness and supportability. The optimal way to achieve this result is to establish a rigorous formal relationship at the onset of system development and between the logistics system design effort and the SE process. Readiness and supportability characteristics must be considered in performing functional and tradeoff analyses, and the SE process provides the framework for enabling the effective acquisition of a supportable system.

System maintainability and supportability goals are best achieved by addressing support requirements as elements of the SE tradeoff and decision criteria. A balanced integration of logistics considerations in the SE process achieves the following objectives:

- produces readiness objectives that will be challenging but attainable,

- identifies realistic reliability and maintainability requirements to achieve these objectives,

- identifies support and manpower drivers, and

- assigns appropriate priority to logistics element requirements in system design tradeoffs.

Four summary points are worthy of mention as a foundation for the logistics/SE linkage:

The SE process is iterative in nature, entailing four elements: requirements analysis; functional analysis/allocation; synthesis; and overall, systems analysis and control. Feedback loops between each of the first three elements are an essential part of the process. Of these, the feedback loop between the synthesis element and the design requirements element represents the verification process, involving testing and evaluation, audits, and design reviews to provide appropriate feedback regarding the attainment of system requirements. Figure 8-1 illustrates the iterative nature of this process.

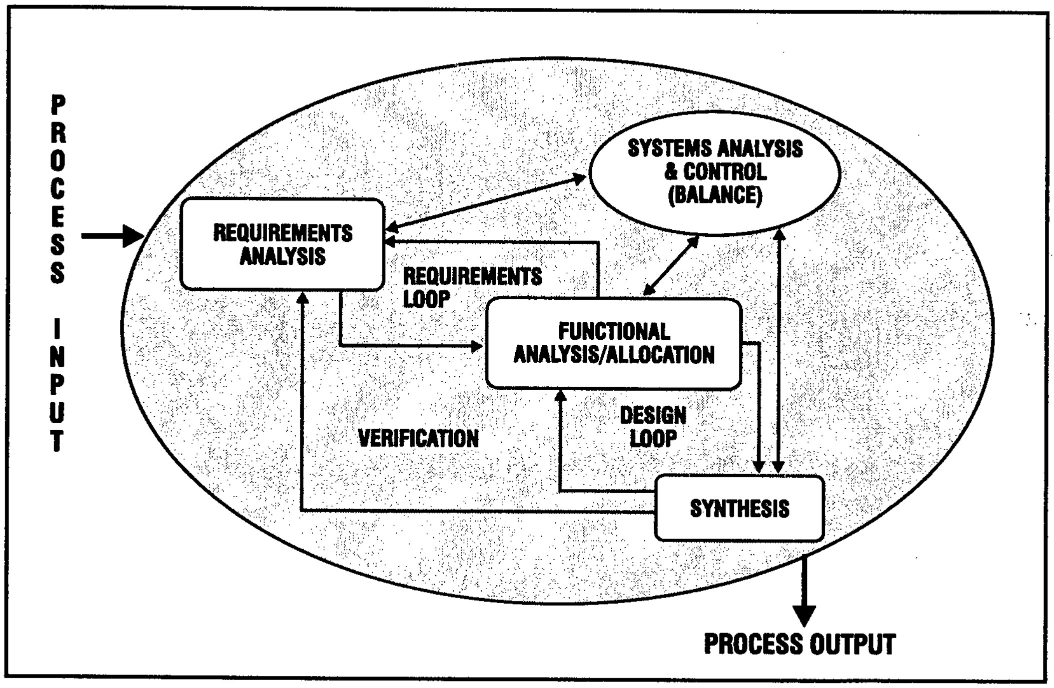


Figure 8-1: The Systems Engineering Process

- Further, SE is applied repetitively within each phase of the acquisition process. A progressive change in the central focus of SE takes place as the development progresses, starting with system-level considerations in the early phases, subsequently overlaid with subsystem considerations (which become the focus in the mid-phases), and followed later by component considerations as the design matures.

- There are many "elements" to be considered in the SE process. Some, like design engineering, come readily to mind when SE is mentioned. Others, like environmental compatibility, electromagnetic compatibility, vulnerability, and commonality, are elements that must be considered throughout the SE process; but they tend to require more SE Integrated Product Team (IPT) effort to keep them in the foreground during tradeoffs, planning, and evaluation. A term has been coined to account for many of these items with names ending in "ility" – the "Ilities." Figure 8-2 combines the many "roots and limbs" of SE into a systemic entity.

- Because logistics considerations are an element of SE, they must be integrated into the SE process from the onset. Supportability and readiness analyses are essential in each stage of the process. A word of caution is necessary, however, regarding the relationship between the design engineer and the logistician. At times, design considerations are likely to be in conflict with the supportability and maintainability concerns of the logistician. In such cases trade studies can be used to identify the proper resolution of such conflicts. When conflicts do occur, it is important that readiness and supportability issues be given the same importance as program schedule and performance. To say that logistics and supportability analyses are a part of SE does not imply that the logistics voice is subservient to the engineering voice on the integrated team or in the project office. Organizationally, the logistician must be a principal player in the development process.

8.1.1 Design Considerations

Many considerations influence system design, and chief among them are the following:

- cost;
- manufacturing/production;
- quality;
- open-system design;
- logistics/supportability;
- reliability, maintainability;
- environment and safety;
- human systems integration; and
- interoperability

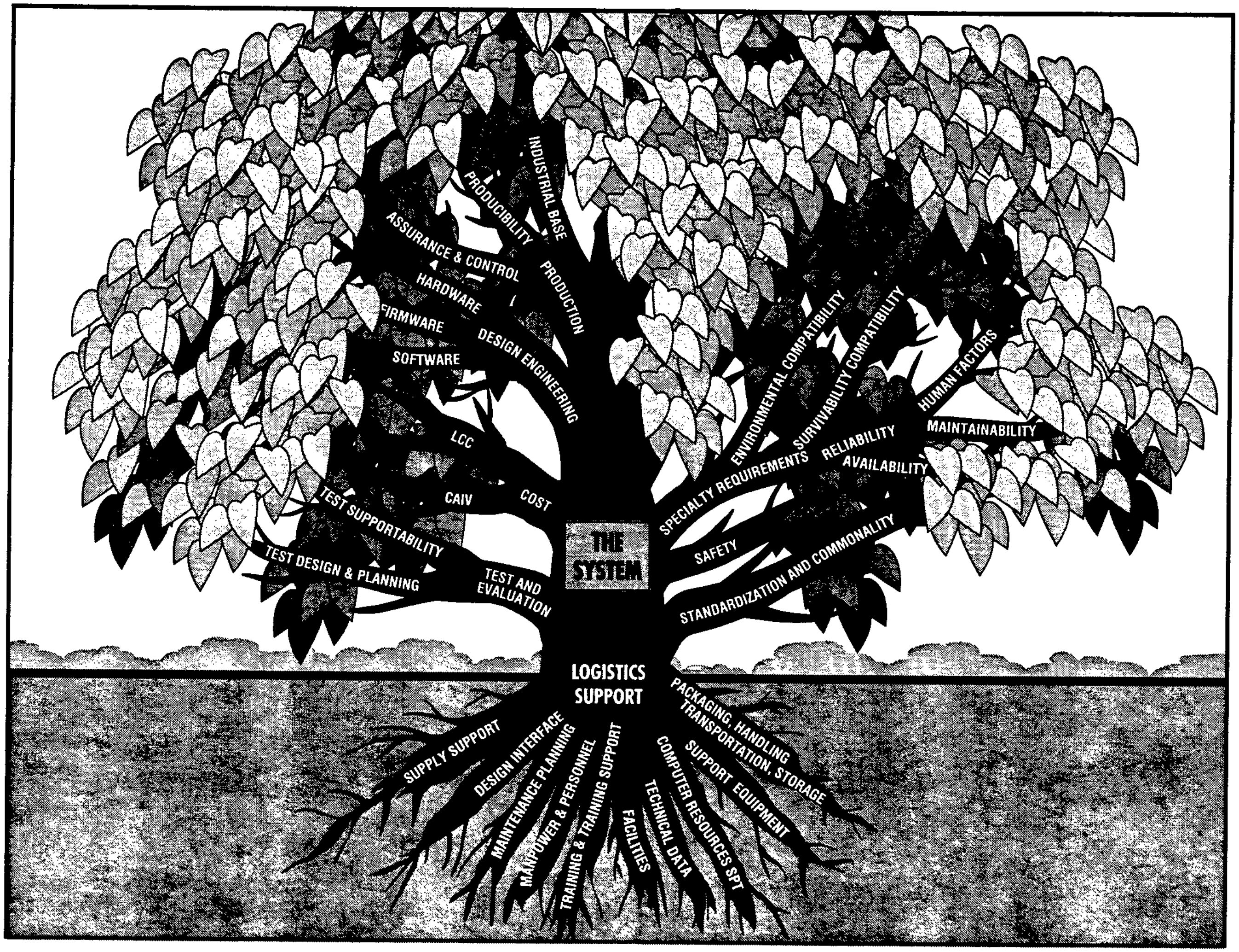


Figure 8-2: Systems Engineering and the "Ilities"

This Chapter will concentrate on three of the topics, i.e., open system design, supportability, and reliability/maintainability. These topics deserve emphasis because of their close association with activities of the Logistics Manager (LM) and, in the case of open system design, because of current DoD policy emphasis.

8.2 OPEN SYSTEMS DESIGN

The following material is presented at the onset of the SE Chapter in recognition of the importance of open systems architecture in reducing system life-cycle cost. The system architecture should be addressed early in a program, as part of the SE process, to maximize the number of potential solutions and, thereby, help reduce program cost. By developing the architecture early in a program, the specific technology used in its implementation can then be chosen as late as possible. The following material has been adapted from the "Open Systems Joint Task Force" section of the *DoD Deskbook.*

8.2.1 Discussion

The **open system approach entails a plan structured to facilitate the use of widely accepted standard products** from multiple suppliers. In instances where system architecture is defined by the specifications and standards used in the private sector, DoD can be one of many customers and leverage the benefits of the commercial marketplace. The open system approach can have a profound effect on the life-cycle cost of a system as discussed below.

- With its implementation, program managers have access to alternative sources for the key subsystems and components to construct DoD systems.
- DoD investment early in the life cycle is reduced, since at least some of the required subsystems or components are likely to be available.
- Production sources can be competitively selected from multiple competitors.
- The system design flexibility, inherent in the open-system approach, and the more widespread availability of conforming commercial products, mitigates potential problems associated with a diminishing defense-dependent manufacturing base.
- Standards-based architecture facilitates upgrades by incremental technology insertion, rather than by large-scale system redesign.

The open system approach is an integrated technical and business strategy that defines key interfaces for the system (or piece of equipment) being developed. Interfaces generally are best defined by formal consensus (adopted by recognized industry standards bodies) on specifications and standards. However, commonly accepted specifications and standards (both company proprietary and nonproprietary) are also acceptable if they facilitate utilization of multiple suppliers. The use of de facto specifications and standards

takes advantage of the fact that firms, particularly those in the commercial arena, frequently develop hardware, software, and systems standards for the design and fabrication of computing, telecommunications, display, sensing, and signal processing systems. Whether interfaces are described by consensus or de facto standards the benefits only accrue if products from multiple sources are economically possible. Although the most common emphasis is on electronic systems, the open system approach is widely applicable, from fasteners and light bulbs to jet engines.

An effective open-system architecture will rely on physical modularity and functional partitioning of both hardware and software. Physical modularity and functional partitioning should be aligned to facilitate the replacement of specific subsystems and components without impacting others. The subsystems and components described by the system design should be consistent with the system repairable level. Subsystems and components below the repairable level will normally not be under government configuration control. Therefore, repairs below the repairable level, if required, will be by the supplier. If the hardware and software is effectively partitioned, processing hardware can be replaced with new technology without modifying application software. In addition, application software can be modified without necessitating hardware changes.

Open-system interfaces must be managed more rigorously than in previous practice. An interface specification or standard is inherently a performance standard, is used as such by industry, and must be recognized as such in DoD. System partitions must not violate the interface, unilaterally extend it, or define it so that it is no longer compliant with the standard. At the start of production, the open-system requirements are published, thus identifying the market opportunities for suppliers.

8.2.1.1 Military Requirements. The open-system approach facilitates the use of lower cost, high-performance subsystems and components, mostly built to commercial specifications and standards within the overall system. The open-system approach does not imply that only consumer-grade products should be used. However, some commercial environments are as demanding as military environments, and commercial products that function in these environments will also function in the military environment. In any case, all open-system designs still must meet military requirements.

8.2.1.2 Legacy Systems. The application of the open-system approach to legacy systems is less obvious but still beneficial. Legacy systems usually have size, space, power, cooling, and shape factor constraints. For these systems, the open system approach can provide Form-Fit-Function Interface (F3I) solutions within existing packaging, power, and environmental constraints. In such cases the open-system solution frequently requires less system resources by using newer, more efficient technologies. The open-system approach is similar to F3I except that the open-system approach emphasizes choosing interfaces that are broadly accepted in the marketplace to allow for as many suppliers as possible over the long term.

8.2.1.3 A Smart Business Practice. The open-system approach is a new way of doing business and an important part of acquisition reform. More importantly, the open-system

approach is a smart way to do business. Hard pressed to maintain the superiority of U.S. military systems within severe budget constraints, DoD program managers need the flexibility of open system to leverage the creativity and competitive pressures of the commercial marketplace. Program managers should ask this question of any proposed design solution: "What provisions have been made to ensure that the widest range of suppliers will have the opportunity to offer their products throughout the program life cycle?"

8.2.2 Example Applications

Examples of open-system applications are such initiatives as the rapid prototyping of application-specific signal processors (RASSP) at the Defense Advanced Research Projects Agency (DARPA) and the F-16 Falcon modular. In addition, the F-22 aircraft (formerly the JAST program) is coordinating its technology investments with industry and academia and other Defense Department science and technology organizations. The F-22 is evolving and demonstrating an open-system architecture, consistent with the new acquisition policies and practices. Another example is the Information Technology Standards Integrated Bulletin Board System (ITSI BBS).

8.2.3 Tools

DoD Technical Architecture Framework for Information Management (TAFIM), Version 2.0, 30 June 1994, is a proven tool for information management. See the information provided below.

8.2.4 POC/Reference

- Office of the Under Secretary of Defense for Acquisition and Technology (USD(A&T))/DTSE&E, tel: 703-695-2300.

- Service Acquisition Executives.

- Director, OSJTF, tel: 703-578-6160/6568 or Home Page — http://www.acq.osd.mil/osjtf/

- DoD 5000.2-R, paragraph 4.3.4.

- USD(A&T) memo of 10 July 1996, Subj: Open Systems Acquisition of Weapons Systems (*Deskbook*) and resulting Service Acquisition Executive's plans for open-system approach for acquired systems.

- DoD Technical Architecture Framework for Information Management (TAFIM), Version 2.0, 30 June 1994, tel: 703-696-1750 or *Deskbook.*

- ITSI BBS Modernization Project (webmaster@itsi.disa.mil), tel: 703-735-8338 or DSN 653-8338

8.3 SUPPORTABILITY ANALYSES

Supportability factors must be considered in an organized manner throughout design and/or planning actions for the system being acquired and for each applicable logistics support element as well. To reiterate, logistics and supportability analyses must be integrated with and be a part of the SE process. In the past this frequently was not the case. Supportability analyses were often accomplished in a nonintegrated fashion, producing reports and recommendations with limited impact on design. Only by including logistics considerations in the design tradeoffs within the SE process and throughout the development cycle can the program achieve its operational goals at the lowest life-cycle cost.

Supportability analyses, when conducted within the SE process, form the basis for decisions on the scope and level of logistics support; and, of equal importance, they lead to performance requirements in the system specification and thus influence design considerations. The analyses, like the SE process, are ongoing throughout the development cycle in iterative fashion. The initial analyses should focus on the relationships of the evolving operational and readiness requirements, planned support structures, and comparisons with existing force structure and support posture. Supportability analyses can include any number of tools, practices, or techniques, many of which are described in Section 8.5 below. The following items are examples of the types of analyses that might be performed to provide appropriate inputs to an integrated Operational Requirements Document (ORD), which reflects an operational and support concept that the user finds acceptable.

8.3.1 Logistics Strategy

The logistics strategy identifies the logistics management structure and authority; what supportability analyses and verification activities are planned; who will be responsible for each activity; and how the results of each activity will be used. There is no standard format for the plan. It should be tailored for each program and should be part of the Systems Engineering Management Plan (SEMP).

8.3.2 Use Study

The use study defines the intended use of the system/component and the operational and support environments of that system/component. Quantitative support factors, such as operational availability (Ao), transportation modes/times, allowable maintenance periods, and environmental requirements (including hazardous materials, hazardous wastes, and other pollutants), are identified. These data are then incorporated into the ORD as appropriate. The use study should include consideration of the following items:

- planned deployment scenarios,
- transportability requirements,
- mission frequency and duration,

- human factors (system complexities and the supportability implications),
- anticipated service life, and
- standardization and interoperability.

8.3.3 Analysis of Comparative Systems

This analysis strives to: 1) define a sound analytical foundation for projecting a new system design and related supportability features, 2) identify aspects that need improvements over those in existing systems, and 3) identify those features that will likely drive cost, support, and readiness of the new system.

8.3.4 Evaluation of Technological Approaches/Opportunities

The purpose of this analysis is to identify technological advancements and state-of-the-art design approaches that offer opportunities to achieve new system support improvements. Use of available technological approaches is emphasized to improve upon projected safety, cost, support, and readiness values; to reduce a new system's environmental impact; and to resolve qualitative support problems.

8.3.5 Postproduction Support

The Postproduction supportability analysis should identify items that are single/dual source or those for which the government cannot obtain data rights. The related plan of action to alleviate projected problem areas should consider organic support capability, production line buy-out, or contractor logistics support agreements.

8.4 SYSTEMS ANALYSIS AND CONTROL

Six major activities and tools are used in systems analysis and control. They are:

- tradeoff studies,
- configuration management,
- data management,
- risk management,
- metrics, and
- technical reviews.

Only the first two activities will be discussed in the Chapter.

8.5 TRADEOFF STUDIES

Desirable and practical tradeoffs among requirements, technical objectives, design, program schedule, functional and performance requirements, and life-cycle costs must be identified and conducted throughout the development process.

8.5.1 Requirements Analysis Tradeoff Studies

The performing activity needs to conduct requirements analysis tradeoff studies to establish alternative performance and functional requirements to both resolve conflicts with and satisfy user requirements. Of primary importance in establishing support alternatives is the following guidance in DoD 5000.2-R, which gives precedence to contractor-provided logistics support in many situations:

> "It is DoD policy to retain limited organic core depot maintenance capability to meet essential wartime surge demands, promote competition, and sustain institutional expertise. Support concepts for new and modified systems shall maximize the use of contractor-provided, long-term, total life-cycle logistics support that combines depot-level maintenance along with wholesale and selected retail materiel management functions. Life-cycle costs and use of existing capabilities, particularly while the system is in production, shall play a key role in the overall selection process. Other than stated above, and with an appropriate waiver, DoD organizations may be used as substitutes for contractor-provided logistics support, such as when contractors are unwilling to perform support, or where there is a clear, well-documented cost advantage. The PM shall provide for long-term access to data required for competitive sourcing of systems support. The waiver to use DoD organizations must be approved by the MDA."

When considering alternative systems or alternative support concepts, the following items are representative of appropriate comparison criteria:

- life-cycle cost comparisons,
- diagnostic characteristics (e.g., Built-in-Test (BIT)),
- energy characteristics,
- battle damage repair characteristics,
- transportability characteristics, and
- facilities requirements.

8.5.1.1 Supportability Factors. DoD 5000.2-R states that: "Supportability factors are integral elements of program performance specifications. However, support requirements

are not to be stated as distinct logistics elements, but instead as performance requirements that relate to a system's operational effectiveness, operational suitability, and life-cycle cost reduction." The following items are examples of supportability issues upon which specific objectives can be based:

- operations and maintenance personnel and staff-hour constraints,
- personnel skill level constraints,
- life-cycle and Operations and Support (O&S) cost constraints,
- target percentages of system failures correctable at each maintenance level,
- mean down time in the operational environment,
- turn-around time in the operational environment,
- standardization and interoperability requirements,
- built-in-fault isolation capability, and
- transportability requirements (identification of conveyances on which the system and its components are transportable).

8.6 CONFIGURATION MANAGEMENT

Configuration Management (CM) is a defined process applying sound business practices to manage the configuration of defense materiel items, their defining technical data, and supporting digital data files. It involves interaction among government and contractor program functions such as SE, design engineering, logistics, test, contracting, and manufacturing. It is best accomplished in an IPT environment consistent with the program infrastructure and concept of operations. There are four distinct functions to configuration management: configuration identification, configuration control, configuration status accounting, and configuration audits.

8.6.1 Configuration Identification

Configuration identification is the identification of documents comprising the configuration baselines for the system and lower-level items (including logistics support elements) and identifiers for those items and documents. When thus identified, an item is known as a configuration item (CI).

8.6.2 Configuration Control

The configuration control process manages the current configuration baseline that results from the configuration identification process. The types and levels of documentation subject to government configuration control authority are defined in pertinent contracts. At an agreed to point in the development process, the government generally accepts configuration control responsibilities and establishes a configuration control board (CCB). Requests for engineering changes are received from government technical, operational, and contract functions; and requests for Engineering Change Proposals (ECPs) are sent to the contractors. Additionally, ECPs and requests for deviations are received from contractors. After disciplined assessment of impact, cost, and risk by the CCB, approval of beneficial changes and the necessary authorization and direction for change implementation by contractors are provided to contractors through the contractual process and to affected government activities through appropriate channels.

Under current acquisition reform initiatives, numerous system support functions will be carried out by industry under contract. In some cases total contractor configuration management, including configuration control, is a distinct possibility. In most cases, however, the government will retain the configuration control function.

A CCB is typically staffed with the IPT responsible for the item, which means the LM will be a part of the team. Government CCBs typically review proposed changes that impact the item's performance requirements only. Conversely, the contractor's change control authority typically evaluates changes that impact the design solution to the item's performance requirements and do not impact the performance requirements.

8.6.3 Configuration Status Accounting

The heart of Configuration Status Accounting (CSA) is a transaction database fed by the transactions that take place under other CM processes. It provides visibility into status and configuration information concerning the product and its documentation. In essence, it provides a track of configuration documentation changes, i.e., the configuration history, and documents the configuration of CIs. With the onset of the DoD initiative to gain total asset visibility, the CSA database will likely be interconnected with the network that provides total asset visibility.

8.6.4 Configuration Verification and Audit

Configuration verification and audit uses each of the following data types at appropriate points in the development cycle:

- schedule information from status accounting,
- configuration documentation for configuration identification,
- the results of product testing,

- the physical hardware or software product or its representation,
- manufacturing instructions, and
- the software engineering environment.

These data are used to verify that the product's performance requirements have been achieved by the product design, and the product design has been accurately documented in the configuration documentation. The process also includes verifying the incorporation of approved engineering changes.

Configuration verification should be an imbedded function of the contractor's process for creating and modifying the product. Process validation by the government in lieu of physical inspection may be appropriate. Successful completion of verification and audit activities results in a verified product and documentation set that may be confidently considered a product baseline, as well as a validated process that will maintain the continuing consistency of product to documentation. MIL-HDBK-61 contains guidelines for conduction configuration audits.

8.7 SUPPORTABILITY ANALYSES

The contractor necessarily performs many supportability analyses; and, thus, it is important that the requirement for analysis reports be clearly addressed in contractual terms. With the advent of acquisition reform, a performance specification (MIL-PRF-49506, Logistics Management Information) has been developed and issued to assist in this regard. It addresses in broad terms each of the following example analyses, which roughly parallel the logistics elements discussed in Chapter 7: maintenance planning; repair analysis; support and test equipment; manpower, personnel, and training; facilities; packaging, handling, storage, and transportation; and postproduction support. Further amplification is provided in the performance specification. However, these topics are presented only as examples of useful support information that DoD managers may want to require from a contractor and are not all-inclusive or exclusive.

A worksheet format for supportability analysis summaries is provided in the specification. Figure 8-3 is a representation of that format. Note that it has a space to be filled in by the DoD manager to indicate what data are required in a specified analysis report to be included in the LMI specification. Another space is provided to identify those data elements not included in the LMI specification. A separate worksheet would be required for each analysis addressed in the contract. In the following section, several types of supportability analyses are discussed.

Page____of ____

SUMMARY TITLE:
SPECIFIC INSTRUCTIONS:
DATA **IN LMI** SPECIFICATION (Please provide the data product title.):
DATA **NOT IN LMI** SPECIFICATION (Please provide the data product title, its definition, and its format.):
SUMMARY LAYOUT (if applicable): Government Provided Contractor Provided

Figure 8-3: Worksheet 1, Supportability Analysis Summaries

8.7.1 Reliability, Maintainability, and Availability (R,M&A) Analyses

The paragraphs that follow in this section discuss analyses that contribute to R,M&A. Supportability analyses play a key role in planning, designing, and fielding a reliable and maintainable system. In organizing this Guide, Chapter 10 has been devoted to the topic of reliability and maintainability. However, the sections that follow are more appropriately placed in this Chapter dealing with SE.

8.7.1.1 Definitions.

- **Reliability** is the probability that an item will perform its intended functions for a specified period under stated conditions. Reliability can be further broken down into mission reliability and logistics reliability:

  — **Mission reliability** is the probability that a system will perform mission-essential functions for a period of time under the conditions stated in the mission profile. Measures of mission reliability include only those incidents affecting mission accomplishment.

  — **Logistics reliability** is the probability that no corrective maintenance or unscheduled supply demand will occur following the completion of a specified mission profile.

- **Maintainability** is the probability that an item will conform to specified conditions within a given period when corrective or preventive action is performed in accordance with prescribed procedures and resources.

- **Availability** is a measure of the degree to which an item is in the operable state. It is ready to commit at the start of a mission, even when the mission is called for at an unknown (random) point in time. The efficacy of the supply support and maintenance systems as well as the Reliability and Maintainability (R&M) characteristics of the item influences the factor in question.

Contracting for Reliability and Maintainability. An important technique for achieving the R&M goals is to provide meaningful contract incentives in the early stages of the program. From program inception through the EMD phase and into the early stages of production, R&M plans and goals should always be a source selection evaluation factor; and the contracts resulting from the source selection should have incentive clauses related to the levels of R&M achieved and verified. The use of contract warranties is often cost-effective in the production and later stages of the program. However, the operational scenario must be evaluated to determine if warranty conditions are practical. Warranties sometimes impose unrealistic handling, shipping, and data collection demands on the operational user and field maintenance organization, making it difficult to enforce the warranty provisions.

8.7.2 Maintenance Planning Analysis

The contractor generally performs the maintenance planning analysis. The resulting summaries provide maintenance planning information to the government; they may be used to develop initial fielding plans for the end items' support structure. The information contained therein is associated with the repairable items to the level of detail specified on contract. Preventive and corrective maintenance actions should be identified along with required spares and support equipment. Additional supporting information, such as elapsed time of maintenance actions, task frequencies, failure rate, mean times to repair, and man-hour allocations by maintenance action and level, should be required for each item.

8.7.3 Repair Analysis

Emanating from the contractor's maintenance repair analysis, these summaries provide the government with conclusions and recommendations. The contract may ask for actions and recommendations for influencing the system design and a listing of which items should be repaired and discarded. For each item being repaired, they may also identify the level of maintenance to be performed and the associated costs. Further, for the system support structure, they may identify the operational readiness achieved and the placement and allocation of spares, support equipment, and personnel.

The summaries should also provide an explanation of the input data used and their source, the operational scenario modeled, assumptions, constraints, maintenance alternatives considered, the analytical method and model used to perform the economic evaluations, and a discussion of the sensitivity evaluations performed in reaching the summary conclusions and recommendations.

8.7.4 Support and Test Equipment

These summaries provide the government with data necessary to register, or verify the registry of, the support or test equipment in the government's inventory. They may provide details of the Test, Measurement, and Diagnostic Equipment (TMDE) calibration procedures, technical parameters, and any piece of support equipment needed.

8.7.5 Supply Support

These summaries provide the Government with information that may be used to determine initial requirements and cataloging of support items to be procured through the provisioning process. The following data items may be included: identification of the system breakdown, maintenance coding, maintenance replacement factors, overhaul rates, roll-up quantities, design change information, associated technical manuals, long lead items, bulk items, tools, test equipment, etc. These summaries may also allow for review of Provisioning List Item Sequence Number (PLISN) assignment or cross-referencing PLISNs with reference numbers.

8.7.6 Manpower, Personnel, and Training Analysis

These summaries provide information to the Government so that it can establish training plans and ensure manpower and personnel constraints are met. The analysis report should identify the items' corrective and preventive maintenance tasks, operations tasks, manpower estimates for each task by maintenance level, personnel skills required to perform the maintenance tasks, and any training required to allow these tasks to be performed.

8.7.7 Facilities Analysis

These summaries identify the facilities required to maintain, operate, train, and test an item. The facilities may be organizational, intermediate, or depot maintenance training, mobile, and test facilities. The summary information contained within shall help plan for any modification to an existing facility or development of a new facility.

8.7.8 Packaging, Handling, Storage, and Transportation Analysis

These summaries identify the packaging, handling, storage, and transportation requirements. They also provide information relevant to the development of a transportability analysis report.

8.7.9 Postproduction Supportability Analysis

The purpose of these analyses is to review life-cycle support requirements of the new system and associated items prior to closing production lines. These reviews ensure the appropriate support for the system over its remaining life. They identify the potential "weak links" in the future support posture, together with alternative solutions to alleviate those anticipated support difficulties.

8.7.10 Redundancy Analysis

In cases where the design concept involves redundancy to meet reliability requirements, the possible result is improved mission reliability gained. However, this gain may be at the cost of reduced logistics reliability and increased support costs. Attempts should be made to improve single-unit reliability whenever possible to preclude the need for redundancy. As a general rule, the designer should use redundancy in mechanical systems as a last option. However, electronic circuitry is a different matter due to size, weight and complexity considerations. Circuits boards can be designed with spare components installed and a logic to switch from a failed component to a backup spare (even multiple spares in succession) to maintain mission readiness. In this instance, the redundancy can be very cost effective, allowing a potentially complex circuit board to remain in operational use without being compromised by a single point of failure.

8.7.11 Failure Modes and Effects Criticality Analysis (FMECA)

FMECA is an analysis procedure whereby each potential failure mode in a system is analyzed to determine its results or effects on the entire system. The analysis then classifies each potential failure mode according to its severity. It further attempts to identify all single points of failure, i.e., those points where failure of the component can cause failure of the entire system. The results of the FMECA must then be utilized in the design process to reduce the probability of failures through design modification. Single points of failure must be eliminated. The benefits of a FMECA include less initial redesign; reduced scope of the Test, Analyze, Fix, and Test (TAFT) effort; enhanced probability of meeting system cost and schedule goals; and improved customer satisfaction. The Society of Automotive Engineers is in the process of writing a commercial standard covering FMECA guidelines.

For more details, read the *Reliability Toolbook: Commercial Practices Edition,* published by the Reliability Analysis Center, IIT Research Institute, Rome, NY.

8.7.12 Reliability Centered Maintenance Analysis

Reliability Centered Maintenance analysis uses information from FMECA to identify items most critical to system availability. The purpose of the analysis is to develop a scheduled maintenance program with the goal of increasing system availability by identifying failures or potential failures before they degrade system effectiveness. The analysis uses a decision tree as a guide for complete analysis of each significant item. While equipment is in operation, preventive maintenance tasks are identified and scheduled on a routine, periodic basis to prevent failures and, thus, keep the equipment running. Preventive maintenance tasks fall into two subcategories: scheduled inspection and scheduled removal.

For more details, read the *Reliability Toolbook: Commercial Practices Edition,* published by the Reliability Analysis Center, IIT Research Institute, Rome, NY.

8.7.13 Test, Analyze, Fix and Test

TAFT is a disciplined process for systematically detecting and eliminating design weaknesses while simulating the operational environment. TAFT should start with the first article available and continue until requirements are achieved. The process is a closed loop in nature; all detected failures are recorded and analyzed, a redesign effort is undertaken to eliminate the cause of failure, testing is resumed, and the redesign is verified. Based on system requirements and the operating environment, the TAFT plan is normally developed by the contractor.

8.7.14 Failure Reporting, Analysis, and Corrective Action System (FRACAS)

The FRACAS is an adjunct to TAFT, in which all failures and faults (not just those that occur in the operational environment testing) of both hardware and software are formally reported. Analyses are performed to determine the causes of failure, and positive corrective actions are taken.

For more detail, read the *Reliability Toolbook: Commercial Practices Edition,* published by the Reliability Analysis Center, IIT Research Institute, Rome, NY.

8.8 SERVICE-LIFE EXTENSION PROGRAMS

A significant number of systems and/or subsystems have life-limiting characteristics, e.g., metal fatigue (aircraft structures), corrosion, or mechanical wear. Such systems are normally designed and tested for a specified service life, but frequently operational requirements demand an extension of the service life beyond the originally planned date. As plans are laid for extending the service life of the system or subsystem, the program office should consider the formation of an IPT to consider all aspects and impacts of the extension. All of the logistics elements must be analyzed for many of them, such as supply support, maintenance, training, and support equipment, are apt to be affected by the extension.

8.9 FLEXIBLE SUSTAINMENT

Flexible Sustainment (FS) refers to "spares" or "parts." It includes what "item managers" do as well as activities of system PMs. It can also be defined as the:

- use of performance-based specifications including the
  - — use of Form-Fit-Function and Interface (F3I) specifications and the
  - — use of nongovernment standards;
- development of innovative, cost-effective life-cycle solutions;
- logical, decision-point-driven process; and
- control of ownership cost by systematically improving reliability.

For further information on flexible sustainment, refer to Chapter 26.

8.10 PROCUREMENT OF TRAINING AND TRAINERS

The Federal Acquisition Streamlining Act of 1994, the Federal Acquisition Reform Act of 1996, and DoDD 5000.1 and DoD 5000.2-R will enable significant changes to DoD's procurement of training and trainers as well as other logistics elements. Best business practices, tempered by risk and threat assessments, must be used to determine where outsourcing, privatization, and competition can improve the performance of the training

mission. As more commercial items enter the inventory, the program manager and his team must continue to utilize acquisition reforms, privatization, and outsourcing of appropriate training and logistics elements.

The procurement of commercial items as elements of the system adds a new dimension to the determination of training sources. The developers of commercial items are likely to have spawned one or more commercial training sources, which may prove appropriate in meeting the DoD requirement. In a similar vein, each acquisition program should examine opportunities for joint training with other DoD components or allied forces to achieve training goals at reduced cost.

8.10.1 Examples/Tools

The recommended way to develop the performance specifications, and hence to identify needed training requirements, is through the use of a training IPT. The members of the IPT must ensure that they identify the Logistics Management Information (LMI) needed to determine and develop the system operational and maintenance training requirements. The LMI, in turn, must identify what training is needed to operate and maintain the system and what training sources are available. These elements include processes, procedures, techniques, training devices, and equipment used to train civilian and active duty and reserve military personnel to operate and support the system. The types of training should include individual and crew training (both initial and continuation) relative to new equipment and initial, formal, and on-the-job training. These LMI requirements must be identified early in the acquisition process to ensure timely development of a training budget that will satisfy system requirements.

8.10.2 POC/Reference

OUSD(A&T)/DTSE&E/DDSE/SESO
Phone: (703) 681-4538
Email: desidegj@acq.osd.mil

9

LOGISTICS PLANNING

P^7: Proper prior planning prevents pitifully poor performance.
Sage advice

9.1 BACKGROUND

Logistics (or supportability) planning is undertaken to provide a plan for the means to support the fielded system. No format is specified; in fact, DoD 5000.2-R states that:

> "Program plans belong to the PM and are to be used by the PM to manage program execution throughout the life cycle of the program. Program plans are a description of the detailed activities necessary to carry out the strategies addressed above. The PM, in coordination with the PEO, determines the type and number of program plans. Program plans, excluding the TEMP, are not required in support of milestone decisions and shall not be used as milestone documentation or as periodic reports."

One of the major themes of DoD 5000.2-R is tailoring, "because one size does not fit all." Common sense and sound business practice will minimize the time it takes to satisfy an identified need. Nevertheless, the prudent Program Manager (PM) will develop a detailed logistics plan for the program, either as a separate entity or as a subset of another program document. Typically, the plan will include the elements of the logistics program and their relationship with overall program management; and it will ensure coordination of logistics issues among all members of the government/contractor Integrated Product Teams (IPTs). Logistics planning provides guidance and direction to the logistics effort. The preparation, coordination, use, and revision of logistics-related plans are major and significant tasks of the Logistics Manager (LM). For a list and description of the ten logistics elements, see Chapter 7.

Another important point made in Section 2.6 of DoD 5000.2-R is that:

> "...supportability factors are integral elements of the program performance specifications. However, support requirements are not to be stated as distinct logistics elements, but instead as performance requirements that relate to a system's operational effectiveness, operational suitability, and life-cycle cost."

9.2 INTERATED PRODUCT TEAM (IPT)

The IPT advises and assists the LM with planning, coordinating, and monitoring of schedules and contractor performance. In the planning effort, the team's support includes:

- preparing Request for Proposal (RFP);
- developing logistics source selection criteria;
- developing the logistics interface of management plans;
- ensuring the accuracy and timeliness of government inputs; and
- evaluating contractor compliance with applicable requirements, regulations, performance and detail specifications, standards, and guidelines.

IPT meetings are often scheduled in conjunction with key program events. Their frequency depends on the intensity of planning activity.

9.3 KEY SUPPORT PLANS/PLANNING

Key planning elements include an overall support plan, representing top-level logistics planning; a combined or separate postproduction support plan; and a combined or separate fielding/deployment plan. Figure 9-1 shows typical considerations for support planning.

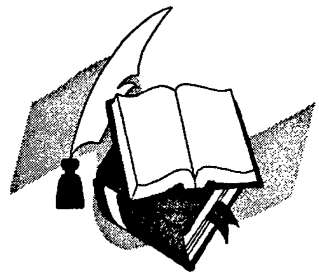
9.3.1 The Top-Level Support Plan

Although the Program Manager may tailor the program documentation, development of a support plan is strongly recommended. Such a plan can act as the principal logistics document for an acquisition program and serve as a source document for summary information in other documents, such as the Test and Evaluation Master Plan (TEMP). The support plan should reflect the set of support requirements documented in the Mission Needs Statement (MNS) and the Operational Requirements Document (ORD); and, therefore, these requirement-oriented documents are a logical starting point in the preparation of a support plan. From that point, the considerations listed in Figure 9-1 could be used as the outline for the plan. The purpose of the support plan is to:

- provide a complete plan for support of the deployed system, addressing and including each support/logistics element;
- provide details of the logistics support program and its relationship with overall program management;

SUPPORT PLANNING

Typical Considerations



- **General**
  - **System Description**
  - **PM Organization and Responsibilities**
  - **Applicable Documentation**
- **Goals and Strategy**
  - **Operation and Organization Concept**
  - **System Readiness Objectives**
  - **Logistics Acquisition Strategy**
  - **Supportability Analysis Scope and Tasks**
  - **Supportability T&E Concepts/Issues**
  - **Logistic Elements**
    - **Maintenance Plan; Manpower; Training; PHS&T; Support Equipment; Supply Support; Tech Data; Facilities; Cmptr Res Spt; Design Interface**
  - **Support Funds**
  - **Deployment, Postfielding Assessment & Postproduction**
- **Logistics Milestone Schedule**
  - **Logistics Comparison to Program Milestones**
  - **Logistics Elements (Any GFE and associated S/E)**
  - **Assignments, Responsibilities and Events**

Figure 9-1 Typical Considerations in Support Planning

- state the acquisition logistics strategy;
- document the logistics decisions on the program;
- provide necessary information on logistics aspects necessary for sound decisions on further development/production of the basic system;
- identify further logistics effects/activities needed; and
- provide the basis for preparation of logistics sections of the procurement package, e.g., Statement of Work, Specification and Source Selection, and Evaluation Criteria.

The support plan describes the overall logistics program, encompassing requirements, tasks, and milestones. The plan is tailored to the specific needs of each program and will address the total system, including the end item, training devices, and support equipment. It becomes the implementation plan for all participating activities and is treated as an integral part of the total program planning process. Effective implementation of the plan is a major management challenge because of the numerous logistics support interfaces.

9.3.1.1 Time Phasing. The Government Program Office normally prepares, coordinates, and starts initial logistics planning and documentation in concert with the system user and the contractor during the Concept Exploration (CE) phase. In addition to plans for support of the fielded system, it provides the basis for other government and contractor planning during this phase and for logistics planning in follow-on phases. It should include specific tasks to be accomplished during the Program Definition and Risk Reduction (PDRR) phase, identify responsible Service agencies and activities, and establish the schedule for task completion. The CE should also project requirements, tasks, and milestones for future acquisition phases.

During PDRR and following phases, the LM may obtain contractor assistance to review and update the supportability planning/plan. The plan will become progressively more detailed as the program design activity progresses. It is normally updated when:

- new program direction is received;
- milestone decision reviews are approaching; and when
- major system configuration changes take place.

9.3.1.2 Format. Again, no standard format exists; but supportability plans typically include: (1) a system description including existing equipment and associated support equipment; (2) program management organization and responsibilities, associated Services, agencies, and working groups/Pits; and (3) applicable documents involving requirements, guidance, and evaluation criteria. Figure 9-1 on the preceding page represents a recommended outline for the support plan.

9.3.1.3 **Concepts, Goals, and Strategy**. The supportability plan typically covers the following topics, which are tailored as appropriate to the system being developed:

- operational and organizational concept involving mission requirements, operational environment, and other required parameters;
- maintenance concept, to later be enlarged into a maintenance plan for support of the fielded system;
- system readiness objectives for both peacetime and wartime situations;
- logistics acquisition strategy involving contractual approaches and incentives associated with Life-Cycle Cost (LCC), Reliability and Maintainability (R&M), and supportability goals;
- supportability analyses strategy, which, because of its importance, may be provided as a separate document that describes in detail the supportability analyses activities and the results expected;

- supportability test and evaluation concepts involving identification of specific test issues related to overall objectives and to each support element;

- the objectives, concepts, tradeoff factors, goals, thresholds, special requirements, responsibilities, and validation and verification requirements for each support element. Additionally, the manner in which the elements of logistics are progressively specified, designed, tested and/or acquired, and then integrated with the other elements;

- support resource funds involving logistics-related life-cycle funding requirements (funded and unfunded), which are identified by element, program function, and appropriation category;

- postdeployment assessments which involve plans that analyze and assess field data feedback related to materiel support and support system performance; and

- the support plan addressing assessment methodology, identifying milestones and responsibilities, and describing the strategies for improvements.

9.3.1.4 Milestone Schedules. The support plan typically provides system program schedule charts showing the interrelationships among logistics tasks and events and overall program milestones. These charts focus on such elements as management, training, testing, maintenance, and supply support; and they identify assignments, responsibilities, and events. The milestone schedules are the baselines for planning in the materiel acquisition process, therefore:

- System program schedule charts, used by program management should depict the most essential support program milestones. The milestones relate critical support capabilities to overall program success.

- Milestone data should include the nature and timing of activities of all supporting contractor and government organizations.

- Milestone schedule charts should include a system program schedule and a summary logistics program schedule. The program and logistics schedules highlight the relationships between key events on the two charts.

- Individual support element program plans should include a program schedule showing key program milestone achievements for that particular element.

- The integrated network schedules should show dependency relationships between logistics elements. Some of the features and benefits of the integrated network are:

— computer-generated critical path methodology (such as the Program Evaluation Review Technique (PERT) and Contractor Performance Measurement (CPM)) to define critical paths and slack times;

— clear visualization for management of interfaces;

— integration with the program management information system (MIS); and

— illustration of the relationship between supportability analyses results and the various logistics elements, to facilitate the identification of support equipment, acquisition events, procurement lead times, etc.

9.3.2 Postproduction Support Planning

The acquisition strategy for ACAT I and IA programs must address postproduction support (Section 3.3, DoD 5000.2-R), and sound business practice would extend this requirement to most other programs. Highlights regarding postproduction support planning can normally be extracted from the support plan, or, the postproduction support plan may be an integral part of, or appendix to, the support plan. A postproduction support plan must deal with the challenging need to sustain effective operations and readiness after contractor delivery of the last production system. Chapter 27 provides a more complete discussion of postproduction support.

9.3.3 Deployment Planning

The LM can also prepare a plan that outlines the schedules, procedures, and actions necessary to successfully deploy a new materiel system. Such plans are given different names in different Service organizations, e.g., deployment plan, fleet introduction plan, materiel fielding plan, and site activation plan. Much of this planning data may be contained in the support plan. Chapter 25 provides a more complete discussion of deployment planning.

9.3.4 Preplanned Product Improvement (P^3I)

Preplanned product improvement is a systematic and orderly acquisition strategy. Beginning at the early phases of system development and planning, it facilitates evolutionary, cost-effective upgrading of a system throughout the life cycle and enhances readiness, availability, and capability. The purpose of P^3I is to develop and field a new system using known technology, while formally planning for the phased introduction of state-of-the-art improvements to that system.

9.4 TOOLS

The Logistics Planning and Requirements System (LOGPARS) is a personal computer-based expert system, which leads an ILS manager through the thought process necessary to plan and execute an ILS program. It helps the user develop acquisition strategy and identify ILS con-

straints. LOGPARS incorporates the required policy, lessons learned, and expert's experience to produce critical ILS program documentation. The systematic, user-friendly approach LOGPARS offers ensures that all considerations are addressed, encourages compliance with existing policy, and eliminates potential for contracting redundant information. The program is available on line at:

http://www.logpars.army.mil/alc/logpars/logpars.htm

9.5 SUMMARY

There are several keys to a successful logistics program. The principal ones are:

- recognition that logistics is involved in all program planning, beginning before program initiation (Milestone 0) when the initial Mission Needs Statement (MNS) is prepared;
- close adherence to the ORD as the baseline for support planning. Chapter 5 of this Guide contains a section on the ORD, which amplifies on this point;
- effective use of the IPT in the planning process;
- preparation of a support plan, with the characteristics outlined in paragraph 9.3.1 above, and tailored to the system being acquired; and
- implementation of the plan as a current and integral part of the overall program.

10

RELIABILITY, AVAILABILITY, AND MAINTAINABILITY[1]

Reliability and Maintainability are Force Effectiveness Multipliers.
Key concept

10.1 INTRODUCTION

Reliable systems result in increased combat capability while requiring fewer spare parts and personnel. Maintainable systems require fewer people and specialized skills; it also reduces maintenance times. These reductions result in lower ownership costs. The advantages go beyond the system itself. Large, complex combat support structures are vulnerable to attack. Reliable systems mean reduced dependence on airlift and pre-positioning. This chapter will discuss policies, definitions, requirements, processes, and techniques. The contents are intended to give the reader an understanding of these policies and procedures, which are used for design of developmental systems and procurement of commercial items.

10.2 RELIABILITY, AVAILABILITY, AND MAINTAINABILITY (RAM) POLICY (DOD 5000.2-R)

RAM issues should be addressed early in the acquisition cycle to meet operational requirements and to reduce life-cycle costs. These RAM issues should be stated in quantifiable operational terms that are measurable during testing. Derive from this what you need to support system readiness objectives.

- Reliability requirements address both mission reliability and logistics reliability.
- Availability requirements address readiness of the system.
- Maintainability requirements address servicing, preventive, and corrective maintenance.

The PM plans and executes the designing, manufacturing, and testing activities that demonstrate the system's performance prior to production(s) and reflect a mature design.

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[1] Sections 10.1 through 10.5.4 are based on the contents of a DSMC Teaching Note prepared by Professor Mark Fantasia, Logistics Management Department, March 1997. The Teaching Note, in turn, is a compilation of hundreds of pages from different sources.

10.3 <u>RELIABILITY, AVAILABILITY, AND MAINTAINABILITY OVERVIEW</u>

10.3.1 The purposes of the DoD RAM (DoD 5000.2-R) are to:

- increase combat capability/effectiveness through:
  - "user" or operator measures by system utilization, operational readiness/availability, and mission success, and
  - mission reliability definition; and

- reduce life-cycle ownership costs through:
  - maintenance manning, and
  - logistics support.

Commonly Asked Questions:

What is Reliability and Maintainability (R&M)? Why is it important?
How do we quantify R&M and its effects?
How much R&M is needed, and what can we expect?
How do we design R&M into hardware and software?
How do manufacturing processes affect R&M?
How do you know how much R&M has been achieved?
How do you assess fielded systems?
How do you plan and manage an R&M program?
How do you account for differences in fielded R&M versus demonstrated R&M?

10.3.2 RAM Definitions

10.3.2.1 <u>Reliability</u>. Reliability is the probability that an item will perform its intended function for a specified interval under stated conditions. Simply stated, it is how long the system can work. Mean Time Between Failure (MTBF) is commonly used to define the total functioning life of a population of an item during a specific measurement interval divided by the failures during that interval. The failure rate (Greek letter lambda) is defined as the number of item failures of per measure of unit life. Sometimes people in the program office erroneously use MTBF and failure rate interchangeably.

- <u>Failure rate</u> can be calculated as follows:
  Failure rate = 1/MTBF (failures over time)
  (Failure rates of components in series are additive)

- <u>Characteristics of failure</u>:
  - Types of failure include:
    - stress/strength (bar in tension),
    - damage/endurance (corrosion/wear/fatigue),

- challenge/response (emergency brake/S/W program), and
- tolerance/requirement (copier machine/measuring instrument).

– Probability of success (confidence interval; confidence level)

– Prediction (subject to much disagreement)

10.3.2.2 Mission Reliability. Mission reliability is the probability that a system will perform mission-essential functions for a period of time under the conditions stated in the mission profile. Measures of mission reliability include only those incidents affecting mission accomplishment.

10.3.2.3 Logistics Reliability. Logistics reliability is the probability that no corrective maintenance or unscheduled supply demand will occur following the completion of a specific mission profile.

10.3.2.4 Maintainability. Maintainability is the probability that if prescribed procedures and resources are used, an item will be retained in, or restored to, a specific condition within a given period. It is the inherent characteristic of a finished design that determines the amount of maintenance required to retain or restore the system into a specified condition. Corrective maintenance can be measured by Mean Time to Repair (MTTR); or, stated in more simple terms, how quickly and easily the system can be fixed. Also, Mean Maintenance Time (MMT) not only includes corrective maintenance but also accounts for preventive maintenance.

10.3.2.5 Availability. Availability is based on the question, "Is the equipment available in a working condition when it is needed?" Availability is defined as the probability that an item is in an operable and commitable state at the start of a mission when the mission is called for at a random point in time. The user is most concerned about this parameter. This reflects the readiness of the system. There are a number of definitions of availability, and it is important to understand the basic ones. All are based on this standard mathematical relationship, with differing definitions of the terms "Up Time;" "Down Time;" and "Total Time":

$$\text{Availability} = A = \frac{\text{Up Time}}{\text{Total Time}} = \frac{\text{Up Time}}{\text{Up Time} + \text{Down Time}}$$

One measure in particular, Operational Availability (Ao), covers all time segments the equipment is intended to be operational. As seen by the following equation, operational availability is based on a mathematical relationship among three characteristics: reliability, maintainability, and the effectiveness of the logistics support system. Reliability is measured as the mean operating time plus mean standby time in an operational condition (represented by Mean Time Between Maintenance (MTBM)). Maintainability includes the mean maintenance time for both corrective and preventive actions (represented by Mean Maintenance Time (MMT)). Logistics support effectiveness is the combination of the logistics delay time plus any administrative delays (represented by Mean Logistics Down Time (MLDT)). The Mean Time Between Maintenance (MTBM) is based on all mainte-

nance actions, whether corrective or preventative in nature. (See the Maintainability Section at 10.5.)

$$Ao = \frac{MTBM}{MTBM + MMT + MLDT}$$

Note: There are a number of program support contracts that require the contractor to meet an A_o requirement. You can see that the contractor would want to control the support structure or have it precisely defined before signing up for A_o.

Another measure, Inherent Availability (Ai), is a measure of the system availability with respect only to operating time and corrective maintenance. Under these idealized conditions, the time involved in preventive maintenance; the delay times associated with all types of maintenance actions; and administrative delays are ignored. Because only unscheduled maintenance actions are considered in this definition, the mean operating time is defined as the Mean Time Between Failure (MTBF).

$$Ai = \frac{MTBF}{MTBF + MTTR}$$

Inherent availability is useful in determining basic system operational characteristics under conditions which might include testing in a contractor's facility or other controlled test environment. Likewise, inherent availability becomes a useful term to describe combined reliability and maintainability characteristics. Inherent availability is also used to define one characteristic in terms of the other during early conceptual phases of a program when, generally, these terms cannot be defined individually. Since this definition of availability is easily measured, it is frequently used as a contract-specified requirement. It is not a good definition to use when estimating the true combat potential for most systems because it provides no indication of the time required to obtain required field support. This term should normally not be used to support an operational assessment.

A third measure, Achieved Availability (Aa), is frequently used during development testing and initial production testing, when the system is not operating in its intended support environment. It is defined over a specific period of time and relates the time the equipment is in use, i.e., operating time (OT), to the sum of the OT plus the corrective maintenance time (TCM) plus the preventive maintenance time (TPM).

$$A_a = \frac{OT}{OT + TCM + TPM}$$

Achieved availability is much more a system hardware-oriented measure than is operational availability, which considers operating environment factors. It is, however, dependent on the preventive maintenance policy, which is greatly influenced by nonhardware considerations.

To summarize, operational availability is the most desirable form of availability to be used in helping assess a system's potential under fielded conditions. Achieved availability and,

to a lesser degree, inherent availability are primarily the concern of the developing organization in its interface with the contractor.

10.3.3 RAM Has Many Other Terms

The terminology used is not standard and tends to depend on the Service and/or system. Be sure you have a clear idea of what the RAM terms mean in the requirements documents and the contract specification. The American Society for Quality Control published a 361-page book entitled, *Reliability, Availability, and Maintainability (RAM) Dictionary*, by Tracy Omdahl. This is the "Webster's Dictionary" of RAM terms.

> The metrics used in most engineering technologies tend to be natural phenomena such as speed, rate of turn and payload. While they may require very careful definition and control of the way they are measured, the metrics themselves are not subject to different definitions...
>
> RMS (reliability, maintainability, and supportability) however, uses metrics that are somewhat specialized rather than naturally defined. As a result, there are more than 2000 terms defined in documents reviewed so far, many of which have the same meaning but different definitions.
>
> Society of Automotive Engineers *RMS Newsletter*, Apr 1990

10.3.4 RAM Requirements and Terms

10.3.4.1 <u>RAM in the User's Requirements Documentation</u>.

10.3.4.1.1 Mission Need Statement (MNS)

The MNS provides the information listed below:

- identifies mission need or deficiency in general terms (not the solution) and
- establishes very general system constraints including logistics (five pages only).

10.3.4.1.2 Assessment of Alternatives (AOA)

The AOA describes the following information:

- trade studies performed during the Concept Exploration phase,
- alternative solutions, which balance effectiveness (lethality, deployability, availability, and dependability) and affordability (costs for deployment, production, operations, and support), and
- best solution identification.

10.3.4.1.3 Operational Requirements Document (ORD)

In the ORD, the following items are included:

- solution-oriented focus on the preferred solution selected following the AOA, and
- user definition of system RAM parameters in operational terms.

10.3.4.2 Measures of Systems Readiness. The "user" or "operator" has various measures highlighted in the ORD that must be translated by the program office into specifications. Here is a sample of user measurements compared to the MTBF (reliability) and MTTR (maintainability) often used in contractual specifications:

OBJECTIVE AREA	RELIABILITY (MTBF)	MAINTAINABILITY (MTTR)
	- - - - - - - - Operational Effectiveness - - - - - - - -	
Increase Readiness (MTTRS)	Mean Time Between Downing Events (MTBDE)	Mean Time to Restore System
Increase Mission Success	Mean Time Between Critical Failures (MTBCF)	Mean Time to Restore Functions (MTTRF)
	- - - - - - - - Ownership Costs - - - - - - - -	
Decrease Maintenance Personnel Costs	Mean Time Between Maintenance Actions (MTBMA)	Mean Labor Hours Per Maint. Actions MMH/MA
Decrease Logistics Support Costs	Mean Time Between Removals (MTBR)	Parts Costs/Removal

We can now see the connection between the two goals of a good RAM program (higher operational effectiveness and lower ownership costs), the users' ORD measurements, and the contractual measurements (MTBF or MTTR in this case). Remember, the developmental testers test to contractual specifications; and the operational testers test to the ORD thresholds. The operational user, the program offices, and the contractor often get very confused over the process of translating ORD numbers to contract specs and vice versa.

10.3.4.3 Contractual Terms – MTBF. The contract must be specific! The user, the program office, and the contractor must understand and agree not only to the RAM terms in both the ORD and specification but also to the definition of "failure" to be used in the

contractual specification. When test results are compiled, the user sometimes misunderstands the meaning of the results relative to the ORD thresholds set forth.

Example: *What counts for a contractual definition of "failure?"*

As a technique, the following can be used. Failure categories: All events occurring during reliability tests are classified as relevant or nonrelevant. Relevant failures are further classified as chargeable or nonchargeable. Make sure that failure classifications are defined on the contract and that the contractor, user, and System Program Office (SPO) meet and agree on these terms early in the process.

Examples of contractually chargeable, relevant events:

- failures due to equipment or part design,
- failures due to manufacturing defects in equipment or parts,
- intermittent events, and
- unverified failures (can not duplicate).

Examples of nonchargeable and/or nonrelevant events:

- installation damage,
- accident,
- mishandling,
- normal operating adjustments,
- events caused by human error, and
- software errors corrected and verified in subsequent testing.

It's easy to see the problems a program manager can face when test results return with many failures reported. But are they failures? Do you want lawyers to determine the definition?

10.3.5 R&M Allocation

The operational user requirements and goals are generally at the system level. These need to translate customer system requirements to lower levels of assembly:

- subsystem,
- line replaceable unit (LRU),
- shop replaceable unit (SRU),
- individual components,
- allocation (shows relationship between individual items and whole system), and
- design target for engineers.

Method 1 – For known equipment in a new application, for example, we would allocate 100 hours MTBF, using F-16 radar with 50 hours MTBF in the F-22 and expecting 50 percent of the environmental stresses in the F-22.

Method 2 – When using a weighted model and expected parts count, the more parts to a subsystem, the more failures are allocated to that subsystem.

Example: Having 3 subsystems with a total parts count of 1000 and with the #3 subsystem having 400 parts or 40 percent of the total, we would allocate to #3 using the following formula: (failure rate) X (.4) = allocation for subsystem #3.

IMPORTANT: Comparative, allocated, predicted, and measured (test results) values are used in the design process. These values impact personnel, planning, support equipment requirements, etc., throughout the system design process. Generally, allocated values are used as the basis for reliability requirements in subcontractor and vendor specifications.

10.4 RELIABILITY TECHNIQUES

10.4.1 Contracting for Reliability

10.4.1.1 Requirements. To attain an increase in combat capability, operational thresholds and goals, these requirements must be communicated in clear operational terms. Then, these operational terms must be properly translated into viable contractual terms understood and accepted by the user, program office, and the contractor. The following items are important to remember:

- requirements must be clear;
- simple design requirements should make a system cheaper to produce, operate, and maintain; and
- requirements should be testable.

10.4.1.2 Source Selection. Source selection is the most important contractor motivational factor. In a source selection for a new or modified system, RAM must be singled out as specific evaluation criteria.

10.4.1.3 Incentives and Warranties. Incentives reward contractors for exceeding minimum program requirements. Warranties hold contractors responsible for sustaining, in the operational environment, the performance levels for which incentives have been paid. Try a fixed-price warranty repair contract with a warranty period of three to five years – long enough for the contractor to demonstrate compliance. If the system does not meet the warranted level, consignment spares should be included to maintain combat capability while repairs and engineering improvements are made. Additionally, the matrix in Table 10A, taken from the *Flexible Sustainment Guide*,

January 1997, gives an idea of the impact that reliability has in selecting from a multitude of warranty types.

TABLE 10A
WARRANTY CONSIDERATION MATRIX

	WARRANTY TYPE																
CONDITION	RIW	R&MIW	T&RIG	MTBF-VT	AG	LSCG	WOS	CLR	MPC	SPL	R&MW	CRW	RW	UFG	UL	CSL	R&EA
Spare – Reliability exceeds system life			X	X	?		X	X	X	X	X	X		X	X	X	X
Spare – Reliability exceeds technology cycle			X	X	?		X	X	X	X	X	X		X	?	?	X
Spare – Costs less than repair			X	X	?		X	X	X	X	X	X		X	X	X	X
Competitive Commercial Repair	?	?	X				X										X
Contract repair (costs less than organic	X	X	X	X	?	?	X		X				X				X
Repair – Organic less									X				X				

WARRANTY LEGEND

RIW	Reliability Improvement Warranty	SPL	Spare Parts Level Warranty
R&MIW	Reliability & Maint. Improvement Warranty	R&MW	Reliability & Maintainability Warranty
T&RIG	Test & Repair Improvements Guarantee	CRW	Component Reliability Warranty
MTBF-VT	Mean Time Between Failures-Verification	RW	Reliability Warranty
AG	Availability Guarantee	UFG	Utility Functions Guarantee
LSCG	Logistics Support Costs Guarantee	UL	Ultimate Life Warranty
WOS	Warranty of Supplies	CSL	Commercial Service Life Warranty
CLR	Chronic LRU Guarantee	R&EA	Repair and Exchange Agreements
MPC	Maximum Parts Cost Guarantee		

10.4.1.4 Tools. Section 17.5 of this Guide describes two contract-related tools, LOGPARS and Turbo Streamliner. Each tool has sections devoted to Request for Proposal (RFP) construction, including RAM references. Website addresses for these tools are provided in Section 17.5.

10.4.2 Predesign: Research and Analysis

Accurately define mission, environmental, and real-life profiles, including the following:

- consider past experiences with field operations and lessons learned;
- define equipment environment (fuel, oil, static electricity); and
- define natural environment (solar, humidity, salt, etc.).

10.4.2.1 Example 1: Natural Environment. A relative humidity of approximately 35 percent is normal for electronics. More humidity causes corrosion and less humidity causes static electricity problems. The Royal Air Force performed experiments with dehumidification units. The tests showed a 22 percent reduction in avionics servicing for both the F-4 Phantom and the Tornado and an 18 percent in the Nimrod. When these tests were reported in the *CODERM Newsletter*, September 1993, another result was noted, "Added bonus... the cabin of the Nimrod no longer smells like a wet dog in a duffel coat."

10.4.2.2 Example 2: Transportation and Storage. Maverick missiles were placed in storage containers and transported by ship to the Mid East. These containers were not inspected upon delivery, and the units were placed in desert open-air storage. One year later, the containers were opened; and they contained 6-8 inches of salt water! The fiberglass containers did not seal properly and the plugs had blown out in shipment.

10.4.2.3 Tool. Sometimes, part of the disparity between laboratory test results for reliability and initial operations test results can be a problem with packaging. At the following address this office will do the packaging engineering for you!

ASC/YHC
Eglin AFB, FL 32542-5000
DSN 872-4609
(904) 882-3779

10.4.3 Design Process

The steps in the design process include:

- performing trade studies;
- performing system and item analyses of the candidate design;
- establishing design criteria; and
- making detailed decisions that transform requirements, resources, and constraints into a design.

10.4.4 RAM Analyses

Four of the more common techniques used in RAM analyses are:

- reliability prediction methods;
- failure mode, effects, and criticality analysis;
- maintainability analysis; and
- reliability centered analysis.

10.4.4 Tools for Analysis

10.4.4.1 Redundancy. Because of the impact to logistics reliability, the PM's interest should be great if the contractor proposes redundancies to meet mission reliability requirements. Space weight and power provisions must be accounted for. Additionally, logistics support must be included when calculating support requirements and costs.

10.4.4.1.1 Exercise. The initial design for a system has three subsystems (A, B, & C) in series (each must work for the system to be successful). Their respective reliability factors for the components of a series system are shown below:

-----[RA (.95)]------[RB (.90)]-------[RC (.80)]
Reliability of the system = R × Rb × Rc or (.95) × (.90) × (.80) = ???

What if the user requirement is .80 for the system? Does the above system meet the requirement? Even without a calculator, we know right away that the system is below .80 since the lowest reliability of a subsystem is .80.

What are the options if you wish to improve the system reliability? What are the risks and/or tradeoffs? What if you choose redundancy?

10.4.4.1.2 Redundancy Characteristics.

When choosing redundancy, there are three major items to consider:

1) The level of redundancy application, e.g., piece part, black box, or complete redundant systems;

2) The redundant element's operating state (Examples: An airport, which is operating two separate ground-control radar units at all times, has active redundancy. Carrying a spare tire in your trunk is passive redundancy.); and

3) The method used to activate the redundant element. (The driver of a car loses mission time changing a flat tire. An electronic switching network senses a failure and automatically switches without loss of mission time.)

10.4.4.3.3 Redundancy Summary

- Redundancy can help improve mission reliability.
- Redundancy generally decreases logistics reliability and increases support costs.
- Try to improve the reliability of a single unit whenever possible; use redundancy as a last option.

10.4.4.2 Failure Modes, Effects, and Criticality Analysis (FMECA). FMECA is a procedure that analyzes each potential system failure mode to determine its results or effects on the system and to classify each potential failure mode according to its severity. The purpose is to provide a safer, more reliable initial design. See Figure 10-2. MIL-STD 1629A is being rewritten to become a Society of Automotive Engineers standard. Ford Motor Company uses the FMECA procedure but uses a different criticality methodology. Sometimes logisticians and systems engineers wish to perform an FMECA down to the piece part; this can be very expensive and is not always needed. The FMECA also helps to identify single points of failure that show how the failure of one component can cause the failure of the whole system. Single points of failure must be identified and eliminated during the design process. To provide a better understanding of a typical analysis, a sample page from a FMECA is presented in Figure 10-3.

10.4.4.2.1 Steps in the FMECA Process:

- What is the function of the system? How does it work?
  - parts?
  - interfaces?
  - software?

- How many ways can it malfunction?

- What happens if an item malfunctions?
  - to the next higher assemblies?
  - system?
  - What is the risk?
  - how critical is each malfunction?
  - what is probability that it can happen?

FAILURE MODES, EFFECTS
AND CRITICALITY ANALYSIS (FMECA)

- **Definition:**
  - a review that examines potential failure modes to determine their effects on equipment
  - employs a "bottoms-up" approach

- **Uses:**
  - shows areas that need corrective action
  - ranks severity of failures/safety
  - identifies reliability-critical components
  - provides input data to systems engineering/logistics

Figure 10-2: Failure Modes, Effects, and Criticality Analysis

SYSTEM NAME	SUBSYSTEM NAME	COMPONENT NAME AND PART NO.	COMPONENT FUNCTION
SPACE SHUTTLE MP SRM 10-00	SRM CASE 10-06	CASE ASSEMBLY, FORWARD 10-05-01 SEGMENT 1U50147-08	
AUTHOR AND COMPANY W. L. HANKINE THIOKOL CORPORATION	**DATE** **JUNE 1983**	**REVISION**	

MISSION PHASE	COMPONENT FAILURE MODE AFFECTED COMPONENT PARTS REASONS FOR FAILURE	FAILURE EFFECT ON A. SUBSYSTEM FUNCTION B. SYSTEM FUNCTION C. MISSION D. VEHICLE AND PERSONNEL	CRITICALITY CATEGORY	CONTROL METHODS TO INSURE A RELIABLE PRODUCT
	ASSEMBLY JOINTS LEAK. PART NO. / PART NAME / QUANTITY PER COMPONENT 1U50131-09 CASE SEGMENT, CYLINDER 2 1U51473-01 CASE SEGMENT, FORWARD 1 1U50228-24 PACKING (O-RINGS) 2/JOINT 1U100269-01 TEST PLUG 1/JOINT 1U50228-15 PACKING (TEST PLUG) 1/PLUG 1. TANG-A-DIAMETER EXCEEDS UPPER LIMIT OR SURFACE FINISH NONCONFORMING, OR IS GOUGED OR BURRED ACROSS BOTH SEAL SURFACES. 2. CLEVIS NONCONFORMING (DIAMETER, THICKNESS, FINISH). 3. CLEVIS O-RING GROOVES EXCEED WIDTH AND/OR DEPTH UPPER LIMITS OR CORRODED. 4. O-RINGS NONCONFORMING OR DAMAGED DURING ASSEMBLY. 5. LEAK CHECK PLUG LOOSE OR WITHOUT O-RING, INNERMOST SEAL INEFFECTIVE PER 1 ABOVE OR THE CONDITIONS OF O-RING ARE PER 4 ABOVE. 6. *FOREIGN MATERIAL IN O-RING GROOVES.* 7. IGNITER FLANGE NONCONFORMING, FLATNESS FINISH. 8. CASE ASSEMBLY JOINT ROTATION CAUSES "LIFT-OFF" FROM SECONDARY O-RING (PRIMARY O-RING WILL REMAIN IN COMPRESSION). 9. EXPANSION OF CLEVIS GAP BECAUSE OF RESIDUAL STRAINS RESULTING FROM MANUFACTURING PROCESSES.	A. HIGH TEMPERATURE GAS FLOW WILL CAUSE METAL EROSION AND PROBABLE BURNTHROUGH AND CASE BURST. B. CATASTROPHIC FAILURE OF SRM. C. MISSION LOSS. D. *VEHICLE AND PERSONNEL LOSS*	1 (1) (1R) (1R) (1R) (1) (1R) (1R) (1R) (1R)	SEE CIL 1. TRAINED, QUALIFIED MACHINIST TO PERFORM MACHINING OPERATION. 2. SPECIAL PROFILE TEMPLATE TO CONTROL LATHE CUTTING HEAD. 3. 100% INSPECTION OF TANG-DIAMETER, CLEVIS, DIMENSIONS AND O-RING GROOVES USING PI TAPE AND STANDARD MEASURING INSTRUMENTS . SURFACE FINISH SAMPLE INSPECTED BY SURF-INDICATOR. 7. A. TRAINED, QUALIFIED MACHINIST TO PERFORM MACHINING OPERATION. B. 100% INSPECTION OF IGNITER FLANGE FLATNESS BY TIR READOUT FINISH IS SAMPLE INSPECTED USING SURF-INDICATOR.
				PAGE OF

Figure 10-3: Sample Page, Failure Modes, Effects, and Criticality Analysis

10.4.4.2.2 Benefits of FMECA:

- less initial redesign
- less test-analyze and fix
- more likely to meet schedule and cost goals
- greater customer satisfaction
  - lower warranty claims
  - fewer liability claims (Lawyers)

10.4.5 Reliability Design for Electronics

Generally, reliability prediction techniques have been based upon empirical models derived from field data found in both military and commercial handbooks. In the next section, you will see some of the problems involved and hear about an alternative called Physics of Failure (POF). Also, the FMECA and redundancy are used in designing electronic systems. Additional tools, such as a parts control program and electronics derating, are also used to improve the reliability for electronic systems.

10.4.5.1 Parts Control Program. A large percentage of hardware is unreliable due to purchased parts. Many may be immature, less reliable, not tested/qualified for your applica-

tion. The purpose of a parts control program is to assist in selection and use of parts in new/modified equipment. A parts control program enhances standardization, interchangeability, reliability, and maintainability. It will also conserve scarce resources you would need to develop components. The quality of the parts is a factor in predicting the reliability of the electronic components up to system level. Currently handbooks are used in prediction methodology and are currently under tremendous criticism. Handbooks such as MIL-HDBK-217F use field data in their methodology. The results are controversial. Proponents believe, as a minimum, the results allow for quick comparisons to be made. (MIL-HDBK-217F is to be retained as a handbook until the Institute of Electrical and Electronic Engineers (IEEE) or a similar organization develops a suitable replacement.)

10.4.5.2 Tools. The Military Parts Control Advisory Group (MPCAG) operates an on-line parts database, prepares standardized part design documentation, and tests parts to qualify vendors. (The qualifying vendors program is currently under scrutiny.) Four Defense Logistics Agency (DLA) organizations can help with parts control:

- Defense Electronic Supply Center (DESC/EPA), Dayton, OH
  (513) 296-5431
  Tubes, resistors, capacitors, semiconductors, relays, and fiber optics.

- Defense Industrial Supply Center (DISC/ESM), Philadelphia, PA
  (215) 697-4395/3007
  Fasteners, seals, springs, and bearings

- Defense General Supply Center (DGSC/SEA), Richmond, VA
  (804) 275-4885
  Refrigeration components, lamps, electrical hardware, lubricants, batteries etc.

- Defense Construction Supply Center (DCSC/SSI), Columbus, OH
  (614) 236-2205/2886
  Gears, pulleys, belts, hoses, tubing, valves, etc.

10.4.5.3 Parts Derating. Derating establishes a design margin to provide the robustness necessary in the operational environment. Derating is the practice of limiting mechanical, thermal, and electrical stresses on components to enhance reliability; it also increases the reliability of individual components and thereby the reliability of the system. Derating is always a compromise among weight, size, cost, and failure rate. Procedures vary with different components when using derating. Microcircuits are derated as a function of operating junction temperature. Mechanical parts are derated in terms of tension, torsion, temperature, and other limits.

CAUTION: "Cookbook" derating criteria generally do not allow you to quantify the magnitude of reliability improvement.

10.4.5.4 Reliability Prediction. Prediction Methods include the following:

- parametric estimations, e.g., failure rate as a function of weight of avionics,
- engineering models, and
- models that are based upon historical reliability data (handouts).

How accurate are the values when a manufacturer states that a transceiver has a "MTBF greater than 7000 hours"? How did the manufacturer come up with the value? These are some of the questions commercial and military program offices have been struggling with for years. MIL-HDBK 217 accounts for stress, environment, and quality as factors for predicting reliability.

10.4.5.4.1 Example: The failure rates for a hypothetical circuit board were predicted using various failure rate models. (Source: *1986 RAMS Proceedings*, p. 162). For the same device (14 components), the following were predicted failures per million operating hours:

Model	**Predicted Failures Per Million Hours**
Bell Communications Research	12,502
MIL-HDBK-217	715,784
British Telecom	1,258
CNET (French)	16,714
Nippon Telephone and Telegraph	9,525

NOTE: "MIL-HDBK 217 is not intended to predict field reliability and, in general, does not do a very good job in an absolute sense. The reasons for this are numerous including different failure definitions for field problems that MIL-HDBK-217 does not account for..."

RAC Technical Brief
April 1990

10.4.5.5 Comparative Analysis. Comparative analysis is a method for predicting the operational reliability or maintainability characteristics of systems yet to be fielded. Using this method, engineers do the following:

- break down the system into subsystems and identify the most comparable subsystems from other similar systems,

- extract field data on existing systems,
- combine engineering factors and field data,
- compare predicated v. actual operating environments, and
- compare predicted v. actual operating environments.

Example. F-22 flight controls would use a combination of F-15 and F-16 flight controls as a baseline. Engineers determine that the electrical components would have a two- to five-fold factor improvement in the F-22. Since F-15 and F-16 field data has a Mean Time Between Maintenance inherent (MTBMi) of 70 hours, engineers would predict 140 to 350 hours MTBMi for the electrical components of the F-22 flight control system.

Bottom Line: The prediction process today is not ideal. Comparative methods are better than handbooks at present. This data, some of it bad, some of it good, finds its way into the support analyses with resultant problems during initial fielding.

10.4.5.6 Physics of Failure (POF). This method holds much greater promise than the old handbook method. One drawback of POF is the time it takes to perform the analysis. The following are quotes and excerpts from Michael W. Deckert article, "Physics of Failure: A Science Based Approach to Ultra High Reliability," *Program Manager,* Sept.-Oct. 1994:

> "Key trade-offs between commercial and military specification components, ruggedized vs. nonruggedized boards, emerging vs. traditional technology, and design layout occur early in a program and can significantly impact the reliability and life-cycle costs of a system. The POF modeling and simulation tools provide program managers and system designers with a science and engineering based approach for evaluating these types of trade-offs that can impact a program."

The POF approach uses modeling and simulation techniques to identify first-order failure mechanisms prior to physical testing. In addition, the POF approach scientifically evaluates new materials, structures, and technologies by designing tests, screens, safety factors, and accelerated simulation.

10.4.5.6.1 Impacts of the POF are listed below:

- POF tools can be used to determine failure mechanisms and assist in accelerated test design.
- POF concepts can improve depot maintenance in three areas: failure verification and isolation, improved reliability after repair, and improved repair verification.

- Currently, unfailed electronic components are assumed to be "as good as new" if they have not failed. With POF, a more reliability centered maintenance approach would be possible, e.g., timed change of a circuit card assembly before actual failure.

- Using the POF, an Environmental Stress Screening (ESS) could be more accurately designed to determine how much useful life remains after the screening is performed.

- Currently the FMECA assumes that integrated circuits are failed, either opened or closed. The FMECA method does not account for intermittent failures. Using the POF method's automated assessment tools, failure times, sites, and stress drivers for the key failure mechanisms can be determined.

10.4.5.6.2 POF software tools. The POF computer tools can reduce the number of hardware tests by improving the design during the Pre-Milestone 0 through Milestone II phases of the acquisition life cycle. In the past, reliability growth programs began after test on hardware was conducted in later phases.

The University of Maryland developed CADMP-2; it is used to assess the reliability of integrated circuit, hybrid and multi-chip module packages.

The University of Maryland developed CALCE; it is a set of integrated tools for the design and analysis of electronic assemblies.

10.4.5.6.3 Other RAM Tools. The Government-Industry Data Exchange Program (GIDEP) is a cooperative activity between government (including the Canadian Department of Defense) and industry participants seeking to reduce or eliminate costs from nonconforming products. With GIDEP, design engineers find a source of qualified parts information. Production engineers find new and innovative techniques to improve production processes and reduce production costs. Reliability engineers use the failure mode and failure rate information during their modeling and assessment studies. Logisticians use mean repair time data in projecting logistics support and resupply requirements. If you want to join the GIDEP, use the following information:

GIDEP Operations Center
PO Box 8000
Corona, CA 91718-8000
DSN: 933-4677
FAX: (909) 273-5200

10.4.6 R&M Testing

10.4.6.1 <u>Test, Analyze, Fix, and Test (TAFT)</u>. TAFT is a disciplined process for systematically detecting and eliminating design weaknesses while simulating the operational envi-

ronment. A closed loop process, TAFT is used to detect failures, feed back data, analyze, redesign, test, and verify fixes. TAFT should start with the first article available and continue until requirements are achieved.

10.4.6.2 Failure Reporting, Analysis and Corrective Action System (FRACAS). FRACAS is a disciplined and aggressive closed-looped reporting system that is an essential part of the TAFT process. With FRACAS, failures and faults of both hardware and software are formally reported. Using this system, analysis is performed to determine failure cause and positive corrective actions are identified, implemented, and verified to prevent further recurrence. Early implementation of FRACAS has the following advantages:

- cost and schedule savings,
- time to assess corrective actions, and
- time to address all failures prior to full-rate production.

10.4.6.3 Environmental Stress Screening (ESS). ESS stimulates assemblies with thermal cycling and random vibration (as a minimum) to precipitate these defects in the developmental facility or the factory. A proper ESS program will be applied early in the design and development phases rather than in the later production phase. An effective ESS program precipitates defects to failure at the lowest level of assembly and does not damage equipment. (A common goal is to use a maximum of 10 percent of component life to conduct ESS.) By moving detection of early failures from the field to the factory, great savings can be attained. Applied early, ESS can pay for itself by correcting defects and by preparing the item under test for subsequent reliability development testing.

10.4.6.4 Reliability Development Test (RDT). The heart of the TAFT process is the formal RDT. The RDT is designed to expose the equipment to thousands of operational use cycles; corrective actions are incorporated and verified during the test. ***Considerable expense and resources are required for the RDT effort.*** With proper emphasis on design fundamentals (see the POF section), parts control, and reducing variability during manufacturing, the expensive RDT process will not be overwhelmed with failures that should have been eliminated earlier. Suggestions on conducting a Reliability Testing Program are found in MIL-HDBK-781A, 1 April 1996. However, the standards committee is requesting assistance in locating or developing a suitable industry standard.

10.4.6.4.1 Example. It is estimated that typical costs to detect and remove defects in the field are $15,000. In the factory, estimated costs to detect and remove defects are $1,500 at the system level, $500 at the LRU level, $50 at the circuit card, and approximately $1 at the piece part level.

10.4.6.4.2 Tool. The Reliability Toolkit: *Commercial Practices*, 1995 Edition, is an excellent source for reliability terms, definitions, and engineering processes, such as require-

ments definition, analysis, design, and testing. For $25, you can get a copy by calling DSN 587- 2608 or by writing to:

> Systems Reliability Division
> Rome Laboratory
> Air Force Material Command
> 525 Brooks Road
> Griffiss AFB, NY 13441-4505

10.4.6.5 Manufacturing RAM Problems. Premature field-system failures are often caused by parts or manufacturing defects introduced during production and repair. Many of the latent defects that result from production errors and weak piece parts can and should be eliminated during production.

10.5 MAINTAINABILITY

Maintainability and reliability are the two major system characteristics that combine to form the commonly used effectiveness index – availability. It is important when we consider that up to one-third of the Services' budgets are earmarked for maintenance. Remember that maintainability is a design consideration, and maintenance is a consequence of that design. As discussed previously, there are two maintenance processes – preventive maintenance and corrective maintenance.

10.5.1 Reliability Centered Maintenance (RCM)

The purpose of RCM is to develop a scheduled maintenance program with the goal of increasing system availability by identifying failures or potential failures before they degrade system effectiveness. The original concept of RCM came from the airline industry. RCM uses information from the FMECA to identify items that are the most critical to system availability. The RCM analysis process uses a decision tree as a guide for complete analysis of each significant item. Preventive maintenance tasks are performed on a scheduled, periodic basis to prevent failures while equipment is in operation. Do not confuse this with other maintenance tasks, such as lubrication and adjustments, needed to keep systems in operation. Preventive maintenance tasks can be divided into two categories: scheduled inspections and scheduled removals.

10.5.1.1 Example:

- Scheduled inspection: Your automobile should be inspected every 15,000; 30,000; and 50,000 miles according to the owner's manual.

- Scheduled removal: The timing belt on your automobile should be removed after 50,000 miles according to your owner's manual.

10.5.2 Test and Diagnostics

Repair of a failed item begins only after identification of the failure. Test requirements should be matched to readiness requirements from the user and the maintenance concept required for the system. A specification may require 90 percent of equipment failures to be identified at the organizational level of maintenance using Built-In-Test Equipment (BITE), technical manuals, and a certain level of skill by the maintainer. Our need for BITE is driven by operational availability requirements that do not permit the lengthy repair times associated with detecting and isolating failure modes in microcircuits. Fault detection, e.g., the engine service light in your car, and fault isolation, e.g., a fault code telling the auto mechanic that the PCV valve is stuck closed, usually are given values by the user. The impact of inadequate diagnostics is usually manifested in long maintenance delays or, if the Built-In-Test (BIT) is faulty, in many removals with a retest OK at higher levels of maintenance. The following are important BIT/BITE considerations:

- What are the contractual definitions of "failure"? Should the contract consider BIT performance only in regards to "BIT addressable" failures (excluding problems not contractually chargeable), or should the contract consider BIT performance in relation to overall mission reliability?

- What failures can BITE detect?

- Will the BITE isolate failures while the basic system is in the operational mode, or must the system be shut down to permit isolation procedures to be performed?

- How do we measure percentage of false alarms? Was the BIT routine erroneous? Is there an intermittent out-of-tolerance condition somewhere?

- What is the percentage of false removals allowed?

10.5.3 Design

Human systems integration plays a major role in maintainability design. Use of virtual reality to check access and visibility among many factors is becoming more commonplace. Some physical design features affect the speed and ease by which maintenance can be performed. These features and pertinent questions are:

- Accessibility: Can the item be reached easily for repair or adjustments?

- Visibility: Can the item being worked on be seen?

- Testability: Can system faults be detected and isolated to the faulty replaceable assembly level?

- Complexity: How many subsystems are in the system? How many parts are used? Are the parts standard or special purpose? Simple systems tend to be both reliable and maintainable. Simplicity can improve both reliability and maintainability by minimizing parts and interconnections and minimizing the number of common hand tools. (The goal is to have no peculiar support equipment or tools in the field.)

- Standardization and Interchangeability: Can the failed or malfunctioning unit be swapped around or readily replaced by an identical unit with no need for re-calibration? Standardization of systems, subsystems, parts, tools, and procedures, with those currently used in the field can lower training costs and risk to readiness, especially during initial fielding of systems.

Besides physical design factors, the frequency of maintenance actions is a major factor in both corrective and preventive maintenance. Reliability can have significant impacts on corrective maintenance; and design features such as self-check-out, reduced lubrication requirements, and self-adjustment would affect the need for preventive maintenance.

10.5.4 Maintainability Demonstration (M-DEMO)

While some elements of maintainability can be assessed individually, a true assessment of system maintainability generally must be developed at the system level under operating conditions and using production configuration hardware. The purpose of an M-Demo is to physically show that the equipment can be maintained. Using the technical manuals, required tools, and other support equipment necessary, the M-Demo is conducted during late Engineering and Manufacturing Development (EMD). Using the actual maintainers and not the contractors is recommended for the M-Demo. MIL-HDBK-471A, *Maintainability Demonstration*, 12 June 1996, outlines suggestions on conducting a demonstration.

10.6 RELIABILITY, MAINTAINABILITY, AND SUPPORTABILITY (RMS) BEST PRACTICES

This section contains a sampling of RMS best practices for the purpose of communicating practices that one or more commercial or military organizations have adopted and reported. Most of the items were gleaned from the Best Manufacturing Practices (BMP) program, a unique industry and government cooperative technology transfer effort. The program maintains a Center of Excellence (BMPCOE) at the University of Maryland. Over 100 participating commercial and military organizations have been surveyed, and best practices validated during the survey are documented in survey reports. The reports are available through the Defense Technical Information Center (DTIC) or by accessing the BMPnet. Requests for recent survey reports or inquiries regarding the BMPnet may be directed to the Best Manufacturing Practices Program (details in the POC/Reference Section 10.6.17).

The examples and tools that follow report some of the RMS best practices that have benefited their users. Hopefully, one or more of them will apply to the reader.

10.6.1 Bar Coding

The sometimes-difficult decision to surrender valuable circuit-board real estate to accommodate board markings has been eased by developing a laser marking method. This method uses bar codes to place part of the serial number on the edges of boards. Not only can the boards be tracked through the manufacturing process using these markings. but also they can be more easily identified among densely packed adjacent boards during servicing of the assembled system. Bar coding is a key tool for the accomplishment of Configuration Management.

Hughes Missile Systems Group, Tucson, AZ

10.6.2 Special Attention to Placement of Maintenance Access Panels (V-22)

Bell-Boeing Vertol

10.6.3 Maintenance Management Software with Graphical User Interface

Now that people are using client/server computing and graphical user interface, the market for maintenance software is growing rapidly and is predicted to top $1 billion by the year 2000.

Metropolitan Atlanta Transit Authority (MARTA)

10.6.4 Automated Test Stations

Lockheed Martin-Government Electronic Systems (LM-GES) uses three AEGIS automated test stations – RF, digital, and analog – for testing various subassemblies. Each test station integrates varied RF, digital, and analog measurements into a single connection for testing ease. The stations allow RF measurements, such as gain, phase, differential phase, and spectrum analysis, to be taken on solid-state transmit/receive modules and RF devices in high volume quantities. The automated test stations use a computer-driven UNIX operating system; and they contain guided probes, which are capable of repeatable measurements needed for high-volume, tight-tolerance requirements. Using these automated test stations, LM-GES can conduct high-speed testing of dynamic and numerous specifications while collecting data at one station. The stations also provide accessibility to data for analysis of individual lot diagnostics for research and development. In addition, the stations provide a production platform for easy conversion to other programs or devices (or maintenance applications).

Lockheed Martin-Government Electronic Systems

10.6.5 Networking to Provide Total Asset Visibility/Integrated Field Service, Etc.

10.6.5.1 Field Service Communications. Litton Applied Technology Division has established a global communications network linking all of its field service representatives throughout the world directly with division headquarters and with each other. The network is low cost but provides some very powerful capabilities. Each field representative has a Zenith laptop PC equipped with a 3-1/2" drive, 20 MB hard disk, communications

modem, and a dot-matrix printer. The software includes Wordstar, d-Base, Lotus 1-2-3, Crosstalk, and a graphics package. The representatives communicate via commercial telephone lines and electronic mail through a PC at division headquarters. Although no classified information is transmitted, all data is scrambled to assure privacy.

Litton Applied Technology Division, San Jose, CA

10.6.5.2 Tool Management. With regard to networking for tool management, the successful tool management system has the correct tool available for the operator when it is required. To accomplish this goal, Texas Instruments (TI) is creating a distributed network of tooling databases that supports methods and tooling, inventory control, purchasing, incoming inspection, and tool regrinding. The network links several manufacturing sites located throughout northern Texas and Colorado providing central coordination for cutting-tool management. Previously, each site maintained its own tool database. In addition, TI developed a central database providing all worldwide TI locations real-time access to TI failure analysis data. The Failure Analysis Database (FADB) is one of many central databases available through TI's global network. Centrally located in Dallas, Texas, with remote access to all TI locations, FADB can be accessed from any TI facility in the world. All data are continually online and updated in real time.

Texas Instruments, Dallas, TX

10.6.5.3 Data Integration in an Nondevelopmental Item (NDI) Facility. The Sacramento Manufacturing and Services Division (SMSD) NDI facility was established to perform nondestructive inspection of intact aircraft, aircraft components, and other items requiring inspection such as antenna components and structural members. The items are inspected for flaws, anomalies, defects, corrosion, Foreign Object Damage (FOD), and repair areas. The inspection data on a particular item is electronically captured as images, waveforms, and other data. The data is then converted to a simple visual format and delivered with the item to the repair shop. Until recently these individual, independent inspections have been analyzed separately with no electronic connection between the systems. Joint Continuous Acquisition and Life-Cycle Support (CALS) technology and numerous networked high-powered computers have enabled overlaying the data between the SMSD inspection systems.

Sacramento Manufacturing and Services Division., Sacramento, CA

10.6.6 Utilization of Optical Memory Cards to Enhance Total Asset Tracking and Visibility

The Army and the Defense Logistics Agency are using optical memory cards to track assets through the supply chain from the wholesale level to the retail level.

CASCOM, Ft. Lee, VA

10.6.7 Online Spares Acquisitioning

McDonnell Douglas Aerospace (MDA) (St. Louis) has developed an online spare parts requisitioning capability that enables customers to access and order spare parts automatically

through the use of Electronic Data Interchange (EDI). Initial operations address Spare Part Order Administration and EDI transactions for request for quote (840) and response (843) and are currently operational with the Navy's Aviation Supply Office. Although the present process for online requisitioning is a mixture of both manual and automated methods, these improvements have greatly reduced requisition time from several months to several days. MDA's (St. Louis) benchmarking results in this area indicate that it can expect further improvements and by fully automating the process, reach a cycle time of about two hours.

McDonnell Douglas Aerospace, St. Louis, MO

10.6.8 Use of a specialized Integrated Product Team (IPT) with a mission to tackle reduction of operating and maintenance costs through a series of compatible actions

French engine manufacturer, SNECMA

10.6.9 Enhanced Reliability Through Advanced Electronic Cooling System

In support of the Standard Hardware Acquisition and Reliability Program, the Crane Site – Naval Surface Warfare Center (NSWC) undertook a project to design and demonstrate a lightweight military avionics electronics enclosure called the Advanced Electronics Cooling System (AECS). The AECS is capable of effectively dissipating thermal power almost five times more dense than in existing configurations using Format E Standard Electronic Modules (SEM-E) to meet projected requirements for the year 2000 and beyond.

Crane Division, Naval Surface Warfare Center, Crane, IN

10.6.10 Reliability Modeling Program

Litton DSD Product Effectiveness Department has implemented an active Reliability Modeling Program. Key elements of this program are the Parts Stress Reliability Predictions (PRED) and the Reliability, Maintainability, and Availability (RMA) Modeling programs.

Litton Data Systems Division, Agoura Hills, CA

10.6.11 Modular Design

At Litton Amecom, software engineers are involved from the beginning of system development; thus they can provide input to developing the software requirements for the system. This assures that the software requirement specifications are complete and can be implemented. Advanced tools are used for software development. One of the most powerful of these is an online, structured method for developing system software design requirements. It is a commercial program produced by Yourdon, Incorporated, called Yourdon Engineering Workbench, which runs on a PC. The structured analysis serves as an organizing tool for the designer. It enables linkage between system requirements and design and assures complete and nonredundant designs. The program facilitates rapid system modeling and design modeling and is self-documenting. It provides an efficient method for

transferring design specifications to software and hardware designers. The structured approach encourages software component modularity for off-the-shelf availability. They have found that many modules can be used in other applications, which reduces development, schedule, cost, and performance risk. The modeling and simulation features of the program allow verification of algorithms, subsystems, and system designs. It can also be used to do sensitivity and "what if" analyses and to establish the system design-dependent mission effectiveness.

Litton Amecom

10.6.12 Standard Interfaces

Vetronics, the electronics and software that control many armored vehicles systems, have become more numerous and complex. United Defense, L.P., Ground Systems Division (GSD) determined that it needed better methods to control how these systems interacted. The basic problems centered on vehicle operators attempting to manage the individual vetronic systems interaction. New procedures were developed to guide the vetronics development and integration process. The strategy was to keep the designs modular and generic, and to maximize their potential for reuse. This strategy was carried out by using standard military and commercial interface specifications, whenever possible, as well as by using an object-oriented design approach.

United Defense, L.P., Ground Systems Division, Santa Clara, CA

10.6.13 Online Logistics Support Database

The logistics support data is derived from the same database used by design and test engineering. The ITT Avionics Division has implemented an online logistics-support database that can be accessed by manufacturing, design, and logistics groups.

ITT Avionics Division, Clifton, NJ

10.6.14 Interactive Computer-Aided Provisioning System

Phalanx provisioning data was originally manually prepared by the ISEA/Design Agency and manually input into the ship's provisioning system by the Inventory Control Point (ICP) provisioner at the Louisville site of NSWC. Hard copies were transmitted back and forth until all data and fields were validated. Louisville has implemented the Interactive Computer-Aided Provisioning System (ICAPS) to automate Phalanx technical documentation development and submission.

Crane Division, Naval Surface Warfare Center, Crane, IN

10.6.15 Continuous Acquisition and Life-Cycle Support (CALS)

Lockheed Martin and AT&T Federal Systems Advanced Technology have applied the CALS concepts in differing fashions as described in the following subsections.

0.6.15.1 Lockheed Martin. Laboratory systems engineering and laboratory testing have been applied to CALS candidate products at Lockheed Martin-Government Electronics Systems (LM-GES) since 1994. The CALS goal of a Contractor's Integrated Technical Information Service has been promoted since the mid 1980s, but implementations have been scarce. LM-GES established a laboratory to provide a test-bed for products determined to provide CALS-compliant solutions to various requirements. Testing is being performed in the context of a nine-step, systems engineering, life-cycle process focused on CALS-defined inputs and outputs.

Lockheed Martin, Government Electronic Systems, Moorestown, NJ

10.6.15.2 AT&T Federal Systems Advanced Technology (FSAT). The Computer-Aided Acquisition and Logistics Support Development group has adopted: (1) an integrated approach including Total Quality Management (TQM) for continuous process improvement, (2) CALS for automation of technical data, and (3) electronic data interchange for automation of business transactions. Applying this integrated approach has resulted in a paperless environment with reduced costs, lead times, and improved quality. Metrics for cost reduction, cycle-time reduction, and the reduction of the number of iterations per illustration have been developed as well as an increased percentage of graphics images used. For example, this initiative has a projected savings of over $3 million for production of documentation. These figures are based on the number of delivered master pages per year of documentation.

AT&T Federal Systems Advanced Technology, and
Bell Labs (Lucent Technology), Greensboro, NC

10.6.16 ISO 9000 Certified Suppliers

Lockheed Martin Electronics and Missiles has instituted a company-wide best practices program that focuses on the quality of the process as well as the product. The approach provides broad coverage of representative Department of Defense and other customer thrusts such as the Army's Contractor Performance Certification Program (CP)2, the Air Force's Manufacturing Development Initiative, ISO 9000, and agile manufacturing. It incorporates them into 12 best practices; each of the best practices is clearly defined and supported by a vice-president-level executive advocate and a management implementation team.

Lockheed Martin Electronics and Missiles, Orlando, FL

10.6.17 POC/Reference

Best Manufacturing Practices Program, 4321 Hartwick Rd., Suite 400, College Park, MD 20740; telephone: 1-800-789-4267; FAX: 301-403-8180; Internet address: http://www.bmpcoe.org

Automated Lessons Learned Collection and Retrieval System (ALLCARS), Internet address: http://www.afam.wpafb.af.mil/LL_Web/allcars.htm

11

LOGISTICS TEST AND EVALUATION

Logistics Test And Evaluation Extends Over The Entire Acquisition Cycle, And Includes Development Test & Evaluation (DT&E), Operational Test & Evaluation (OT&E), And Supportability Assessments.

Truism

11.1 POLICY AND OBJECTIVES

11.1.1 DoD 5000.2-R Policy

Test and evaluation (T&E) planning (including logistics T&E planning) begins at Phase 0, Concept Exploration. Test and evaluation planning addresses Measures of Effectiveness (MOEs) and Measures of Suitability (MOSs) with appropriate quantitative criteria. These criteria include test event or scenario descriptions, resource requirements (e.g., special instrumentation, test articles, validated threat targets, validated threat simulators and validated threat simulations, actual threat systems or surrogates, and personnel), and test limitation identification.

Accredited modeling and simulation is applied, as appropriate, throughout the system life cycle in support of the various acquisition activities, including requirements definition and logistics support. Program Managers (PMs) integrate the use of modeling and simulation within program planning activities; plan for life-cycle application, support, and reuse of models and simulations; and integrate modeling and simulation across the functional disciplines.

The Test and Evaluation Master Plan (TEMP) focuses on the overall structure, major elements, and objectives of the test and evaluation program that are consistent with the acquisition strategy. It should include sufficient detail to ensure the timely availability of both existing and planned test resources requirements to support the test and evaluation program.

A TEMP shall:

- be prepared for all Acquisition Category (ACAT) I and ACAT IA programs and other acquisition programs designated for the Director, Operational Test and Evaluation (DOT&E), Office of the Secretary of Defense (OSD), or OSD's test and evaluation oversight (**10 USC §2399**);

- be approved by the DOT&E and the Director, Test, Systems Engineering, and Evaluation (DTSE&E); and

- provide a road map for integrated simulation, test and evaluation plans, schedules, and resource requirements necessary to accomplish the test and evaluation program.

The TEMP format and procedures are provided in Appendix III of DoD 5000.2-R. This format may be used at the discretion of the Milestone Decision Authority (MDA) for other ACAT II and III programs and for highly sensitive classified programs.

11.1.2 Logistics T&E Objectives

The overall objectives of logistics T&E are:

- to provide assurance of system supportability under anticipated wartime conditions;

- to verify that the logistics support planned and developed for the system is capable of achieving established system readiness levels within the established life-cycle cost thresholds; and

- to demonstrate that system readiness objectives are attained at peacetime utilization rates.

11.2 MANAGEMENT ISSUES

Logistics test and evaluation extends over the entire acquisition cycle; and it includes Development Test & Evaluation (DT&E), Operational Test & Evaluation (OT&E), and supportability assessments. The Logistics Manager (LM) must be a participant in the Test and Evaluation Integrated Product Team (T&E IPT) planning of DT&E and OT&E and is directly responsible for the planning of postdeployment supportability assessments. An integrated database of all data from Developmental Testing/Operational Testing (DT/OT) logistics evaluations provides larger sample sizes that are needed for confidence in the validity of test results and as an aid to minimize redundant testing.

11.2.1 Development Test and Evaluation (DT&E)

DT&E is part of the engineering design and development process. It verifies the attainment of technical performance specification thresholds and objectives. Figure 11-1 identifies the T&E objectives of major interest to the LM. The tests are conducted generally by the prime contractor and developing agency and under conditions that are not fully representative of field operation.

11.2.2 Operational Test and Evaluation (OT&E)

OT&E is conducted to assess a system's operational effectiveness and suitability, including the adequacy of the system's logistics support (Figure 11-1) during pre-Milestone (MS) III phases of development. The tests or assessments are normally conducted and data is normally evaluated by an independent field agency that is separate from the developer and user. Initial Operational Test and Evaluation is performed in an environment as operationally realistic as possible. A complete evaluation of the system's supportability design parameters (e.g., operational R&M) and the logistics elements should be conducted during the Engineering and Manufacturing Development (EMD) phase, and should employ production representative systems.

ACQUISITION PHASE / TEST TYPE	CONCEPT EXPLORATION & DEFINITION	PROGRAM DEFINITION AND RISK REDUCTION	ENGINEERING & MANUFACTURING DEVELOPMENT	PRODUCTION, FIELDING/DEPLOYMENT AND OPERATIONAL SUPPORT
DEVELOPMENT T&E	• Select Preferred System and Support Concepts	• Identify Preferred Technical Approach, Logistic Risks, and Preferred Solutions	• Identify Design Problems and Solutions Including: —Survivability —Compatibility —Transportation —R&M —Safety —Human Factors	• Ensure Production Items Meet Design Requirements and Specifications • Ensure Adequacy of System Design Changes
OPERATIONAL T&E AND SUPPORTABILITY ASSESSMENT	• Assess Operational Impact of Candidate Technical Approaches • Assist in Selecting Preferred System and Support Concepts • Estimate Operational Compatibility and Suitability	• Examine Operational Aspects of Alternative Technical Approaches • Estimate Potential Operational Suitability of Candidate Systems	• Assess Operational Suitability —Operational R&M —Built-In Diagnostic Capability —Transportability • Evaluate Logistics Supportability —Effectiveness of Maintenance Planning —Appropriate Personnel Skills/Grades —Appropriate Spares, Repair Parts, Bulk Supplies —Adequate Support Equipment, Including Effective ATE and Software —Accurate and Effective Technical Data; Validation/Verification of Technical Manuals —Adequate Facilities (Space, Environmental Systems, Storage) —Effective Packaging, Lifting Devices, Tie-Down Points, Transportation Instructions	• Ensure Production Items Meet Operational Suitability Requirements • Demonstrate Attainment of System Readiness Objectives • Update O&S Cost Estimates • Evaluate Operational Suitability and Supportability of Design Changes • Identify Improvement Required in Supportability Parameters • Provide Data Required to Adjust ILS Elements

Figure 11-1: Logistics Objectives in the T&E Program

This evaluation may continue into the next phase with pilot or full-rate production items. All logistics elements should be provided in a condition or configuration that is close to or identical to the one provided after deployment. As a minimum, the operational test environment should include:

- representative military operation and maintenance personnel;
- trained personnel, using a prototype of the planned formal training program;

- draft technical manuals;
- production representative systems;
- support equipment selected for operational use; and
- realistic tactical environment.

11.2.3 Supportability Assessment

A supportability assessment is performed in two general stages: (1) assessment as part of the formal DT&E and OT&E programs and (2) assessment performed after deployment through analysis of operational, maintenance, and supply data on the system in its operational environment. Participating with the project office T&E IPT in the planning of DT&E and OT&E programs, the LM develops detailed logistics T&E objectives for each acquisition phase and incorporates these objectives into the formal test programs.

Assessments of some logistics elements may require additional or separate tests. Two common examples are validating the accuracy of technical manuals and demonstrating maintainability to evaluate maintenance activities. These are generally initiated prior to the formal test programs in order to reduce delays during testing. The evaluation of logistics elements is discussed in 11.2.4 below. The LM is responsible for the planning of postdeployment supportability assessments. General objectives are listed in Figure 11-1. The planning should identify the following items:

- objectives and specific planned uses of the assessment analyses and reports;
- specific parameters to be estimated (e.g., operational availability, Operations and Support (O&S) costs, maintenance replacement rates for spares and repair parts, and operational reliability and maintainability);
- data sources and methods of collection;
- statistical validity required;
- duration of data collection;
- data analysis methods and reports; and
- planned utilization of the assessment reports.

11.2.4 Evaluation of logistics elements

The eight logistics elements listed below should be evaluated individually to determine the impact of that element on system readiness and system ownership costs. The T&E IPT is faced with the same scheduling challenge in this regard as with all testing during system development. Appropriate tests and evaluations should be accomplished as early as feasible to bring problem areas to light and resolve them. On the other hand, most testing and evaluation should be conducted on production representative items to bring confidence and validity to the test results. As a practical matter, the majority of the logistics T&E will take place in the latter stages of EMD or in the early stages of the Production, Fielding/Deployment, and Opertional Support phase, when the logistics elements are available. Refer to Figure 11-1.

11.2.4.1 Maintenance Planning. This element is evaluated to verify proper assignment of maintenance tasks to maintenance levels and the appropriate selection of support equipment and personnel to perform maintenance tasks. A structured maintainability demonstration is an effective evaluation mechanism; at a minimum, the demonstration should include all organizational and selected intermediate level tasks.

11.2.4.2 Manpower and Personnel, Training, and Training Support. These factors are tested and evaluated to ensure that:

- the number of personnel and the skills they will need to support a system in its operational environment are identified;

- the effectiveness of the government personnel training program, as reflected in their ability to operate, support, and maintain the materiel system under test, is assessed; and

- training devices are provided in the proper quantities and at functional areas.

11.2.4.3 Supply Support. This element is evaluated to verify that the quantities and types of items and supplies designed to maintain the system in its prescribed state of operational readiness are adequate. Both peacetime and wartime usage rates should be evaluated.

11.2.4.4 Support Equipment. This element is evaluated to determine its effectiveness, the validity of the planned requirements, and the progress achieved toward meeting those requirements. Test and evaluation should verify that all items function as required and that no requirement exists for items not listed. Compatibility, integration, and interoperability are significant evaluation issues.

11.2.4.5 Technical Data. The data are tested and evaluated to assure that they are accurate, understandable, and complete, as well as able to satisfy maintenance requirements at projected skill levels.

11.2.4.6 Computer Resources Support. This element supports both embedded computer systems and the automatic test equipment that provide support for the end item. In general, evaluation of this area addresses the adequacy of the hardware and the accuracy, documentation, and maintenance of computer software routines. Built-in test routines programmed into the software of a complex device, such as a computerized aircraft fire-control system, would be covered in this area of the evaluation.

11.2.4.7 Facilities. Facilities are evaluated to determine whether the following areas have been defined and satisfied:

- facilities requirements in terms of space, volume, capital equipment, and utilities necessary for system operation and maintenance; and
- environmental system requirements (for example, temperature, humidity, and dust control) associated with operations, maintenance, and storage facilities.

11.2.4.8 Packaging, Handling, Storage, and Transportability. These evaluations will determine whether:

- provided transportability instructions are adequate;
- conventional types of lifting, loading, and handling equipment can handle the system;
- lifting and tie-down points conform to appropriate size, strength, and markings standards;
- the system is adaptable to prescribed forms of transport (surface, sea, and air, as applicable);
- the equipment and personnel can be moved with ease from the ships to shore assembly points in logistic-over-the-shore operations; and
- transport and storage-handling damages are limited effectively by packaging.

11.3 TESTING COMMERCIAL/NDI ITEMS

The incorporation of commercial or Nondevelopmental Items (NDI) into DoD systems poses special T&E challenges. The contractor T&E data should be thoroughly reviewed. As appropriate, an additional, tailored T&E program should be developed and executed to provide data not available from the contractor's program and to reflect the environment and operating demands of the system under development.

11.4 STATISTICAL VALIDITY

There is a tradeoff among the numbers of test hours that can be expended, the failure rates experienced during the testing, and the degree of precision that statistical analyses permit us to glean from those tests. In practice, test hours are limited by funds available for testing, the numbers of items available for test, time available for testing, and the way in which failures occur. While it might be possible to exercise some control over funding, failure rates and their distribution among the various components and subsystems are inherent to the system's design and use. Careful attention to the selection of statistical methodologies is important for both development and operational testing of the logistics support of a system.

PART III

LOGISTICS RESOURCES AND TOOLS

12
LOGISTICS COST ESTIMATING

"Never invest your money in anything that eats or needs repairing."
Billy Rose

12.1 POLICY

On 15 March 1996, the Secretary of Defense promulgated the latest revision to the DoD 5000 series acquisition directives. The covering memo outlined six major themes contained in the updated documents. One of those major themes is that, "The acquisition process must consider both performance requirements and fiscal constraints. Accordingly, cost must also be an independent variable in programmatic decisions, with responsible cost objectives set for each program phase." This theme is to be known as Cost As an Independent Variable (CAIV).

Every issuance of the acquisition policy documents has emphasized this same theme, and correctly so. CAIV is the latest in a series of terms intended to put focus on life-cycle cost. Past and current initiatives have addressed Should Cost, Budget To Cost, and Design To Cost (DTC), with variations such as Design-to-unit Production Cost (DTUPC) and Design to Life-cycle Cost (DTLCC). Additionally, terms such as Life-cycle Cost Procurement (LCCP) and Life-cycle Cost Management (LCCM) have come into common usage as cost concepts have been applied in an effort to comply with policy documents. The current DoD 5000.2-R includes Program Acquisition Unit Cost, Average Procurement Unit Cost (undefined), and Average Unit Procurement Cost.

To understand what is new about Life-cycle Cost (LCC), review the way it is woven into the policy directives and consider the concept in the context of the overall agenda of acquisition reform in the mid 1990's. By 1991, when the policy directives were last updated, LCC was strongly encouraged and described on about 20 of the 900 pages in the policy directives. However, in 1991 LCC and DTC were encouraged but optional at all levels of acquisition program decision making. When the policy documents were overhauled for the 1996 issuance, the overall page count decreased to less than 100 pages; and LCC, under its new title CAIV, was mentioned approximately 25 times thoughout the documents. Clearly, the relative importance of LCC greatly increased; and, more importantly, it is now mandatory for the major acquisition category programs.

Many contemporary political issues dictate that control of the costs associated with both acquisition and ownership of weapons systems receive an unprecedented level of management attention. On 4 December 1995, the Under Secretary of Defense for Acquisition and Technology issued a memorandum on the subject of, "Reducing Life-Cycle Costs for New and Fielded Systems." The memorandum started with the statement that, "Reducing the cost to acquire and operate the

department's equipment while maintaining a high level of performance for the user is my highest priority."

Some readers may ask if this is just the same concept as the old 5000-series directives, which are described as "Design-To-Cost." In fact, the concept is the same, and the LCC analysis process is the same. But the emphasis and environment are different. What was optional in the old LCC directives is now mandatory, and a fundamental change has occurred in DoD-level acquisition strategy. For more than 30 years, DoD acquisitions were reactions to a constantly changing Soviet technological threat. To counter this threat DoD acquisitions experienced an evolving set of requirements because of the length of the acquisition life cycle, changes in the enemy's capabilities, and emerging technological opportunities. These factors regularly resulted in programs that experienced significant cost growth and the accompanying negative reactions of those who did not understand the reasons for the growth. Added to this is a current perception that some portion of the changes and cost growth was unwarranted. This has been referred to as the 110 percent solution to a requirement. Various contractor and program staff members were adding "bells and whistles" on systems to the point where "gold plating" was not unusual. In hindsight, it appears that serious discussions between the developer and the user, with a view toward holding cost growth down, did not always take place. CAIV is a change to the former trend. CAIV and LCC are likely to be much more of a cost-holding force for many socioeconomic reasons, including peace dividend mentality, user paying the support bill within Defense Working Capital Fund (DWCF), sustainment bill taking all of the budget (proportionally few defense dollars available for modernization), etc.

The objectives of CAIV follow:

- setting realistic but aggressive cost objectives early in each acquisition program,
- devising and employing a process for accomplishing cost-schedule-performance tradeoffs during each acquisition phase and at each milestone decision point,
- managing risks to achieve cost, schedule, and performance objectives,
- devising appropriate metrics for tracking progress in setting and achieving cost objectives,
- motivating government and industry managers to achieve program objectives, and
- establishing in-place additional incentives to reduce operating and support costs for fielded systems.

The challenge to the acquisition logistician is to champion the implementation of these concepts actively and aggressively through participation in the various Integrated Process Teams (IPTs). Knowledgeable use of Life-cycle Costing can be the catalyst in assuring affordability of systems when fielded for operations by the user.

12.2 LIFE-CYCLE COST (LCC) OVERVIEW

The life cycle of a system begins with the determination of a mission requirement and includes research and development (R&D), production, deployment, operation, support, and eventual disposal or demilitarization by the Department of Defense (DoD). Program phases may overlap considerably; in particular, R&D may not be completed before procurement begins.

12.2.1 LCC Analysis Is an Iterative Process

The LCC estimate must reflect program changes as they occur. LCC Management (LCCM) is the program office discipline used to incorporate LCC in program office decision making. The lead acquisition logistics manager will generally be tasked to provide Operating and Support (O&S) cost support for the LCC estimate.

12.2.1.1 LCC Breakdown. For purposes of cost estimating, LCC is typically divided into research and development, procurement, O&S, and disposal. The following descriptions provide a brief summary of the costs associated with each life-cycle phase (see Figure 12-1):

- R&D. R&D consists of those costs incurred from program initiation at the conceptual phase through the end of engineering and manufacturing development. R&D costs include the cost for feasibility studies, modeling, tradeoff analyses, engineering design, development, fabrication, assembly and test of prototype hardware and software, system test and evaluation, associated peculiar support equipment, and documentation.

- Procurement. Procurement includes the costs associated with producing or procuring the prime hardware, support equipment, training, data, initial spares, and facilities.

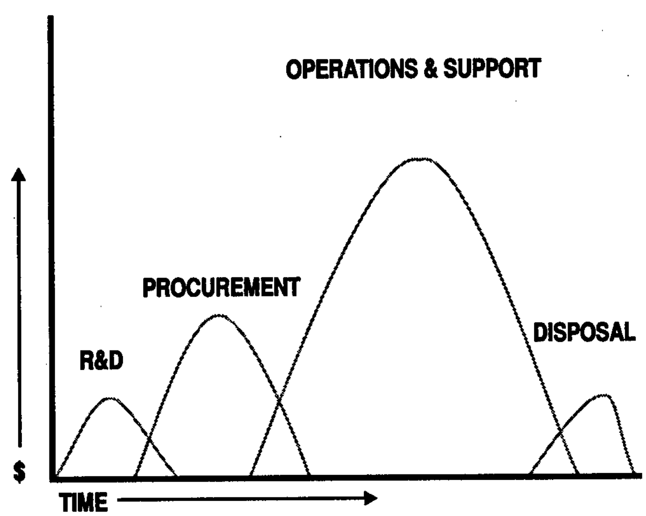

Figure 12-1: Growth in Weapon System Life-Cycle Cost

- O&S. O&S consists of all costs incurred by the DoD to field/deploy the system including personnel, consumable and reparable parts, fuel, shipping, and maintenance.

- Disposal. Disposal captures costs associated with deactivating or disposing of a materiel system at the end of its useful life. Disposing of a materiel system can result in additional costs or a salvage value depending on the disposition. This cost is normally insignificant compared to the total LCC. The main exceptions to this include disposal of nuclear waste, missile propellants, and other materials requiring expensive detoxification or special handling.

12.2.1.2 Design to Cost (DTC) Establishes LCC as a Design Parameter. DTC requires the establishment of cost goals and strives to incorporate these goals into the system design. Initial DTC activity focuses on identifying system cost drivers, potential risk areas, and cost/schedule/performance tradeoffs. As development continues, efforts focus on identifying areas requiring corrective actions. Cost reduction techniques are applied to such areas to keep costs within an acceptable range.

12.2.1.3 Depth and Accuracy of Estimates. The depth and accuracy of cost estimates depend on the acquisition program phase and the use of the estimate. At Milestone I, very little will be known about the detailed design of the proposed system. However, affordability of the program must be evaluated, alternatives compared, and DTC goals established. The most significant impact on costs can be achieved prior to Milestone I. This is when major decisions, such as the selection of a manned vs. an unmanned system are made. Such decisions lock in major costs for the system. The opportunity to influence cost diminishes as the program matures. See Figure 12-2 and Figure 12-3.

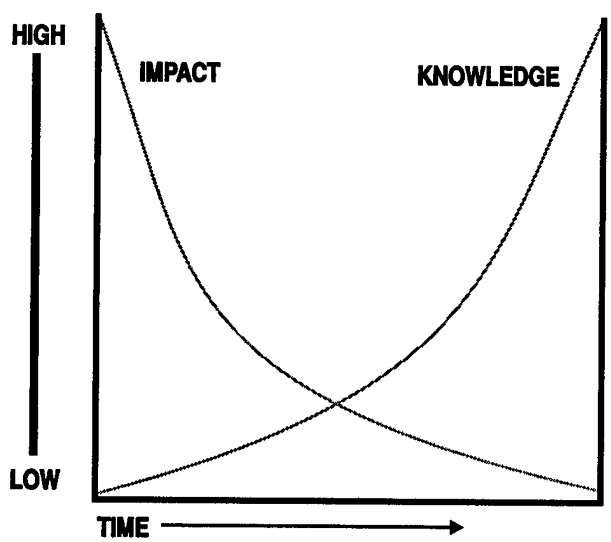

Figure 12-2: Entire Acquisition Time Line

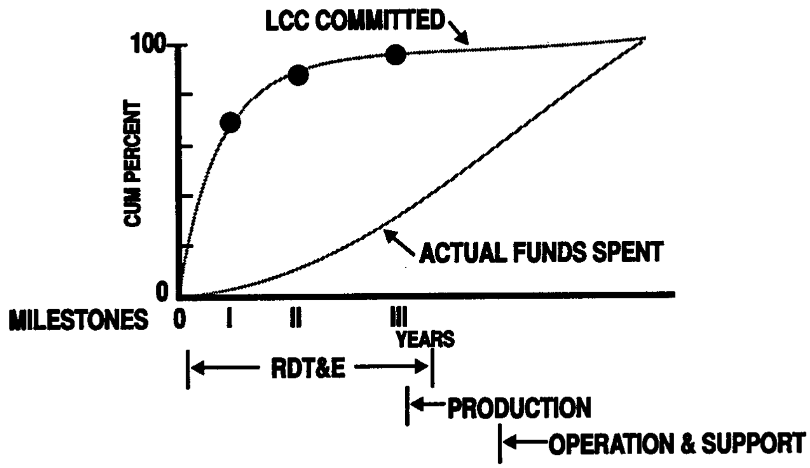

Figure 12-3: Early Impact of Decisions on Life-Cycle Cost

12.3 OPERATIONS & SUPPORT (O&S) COST OVERVIEW

O&S costs are those incurred by the DoD for the peacetime operations and maintenance of a system throughout its life cycle. Major determinants of O&S costs are design characteristics, reliability, maintainability, and mission requirements.

12.3.1 Uses of O&S Cost Information

O&S cost information is used for a variety of purposes throughout the acquisition process, including the following:

- support of the design-to-cost program,
- support of milestone decisions,
- discrimination among alternative designs,
- support of budget estimates, and
- conducting Tradeoff Analysis.

12.3.2 Depth and Accuracy of Estimates

As part of LCC estimating, the detail and accuracy of the O&S cost estimate also depends on the acquisition program phase at the time the estimate is initiated/revised/completed and the intended use of the O&S estimate. As a system is developed and designs and support concepts are evolved, O&S cost estimates and cost comparisons should become increasingly accurate. By Milestone II, the subsystem O&S cost drivers should be identified. Cost drivers are characteris-

tics of a system or subsystem that influence a major share of the system cost. An understanding of the system's design is necessary for identification of system cost drivers.

The O&S cost estimates prepared for Milestone III are based on system design characteristics, deployment schedule, and operation and maintenance concepts. Operating experience obtained during system test and evaluation is used to verify progress in meeting O&S cost goals and to identify problem areas.

12.3.3 Summary of the LCC Analysis Process

The analysis process follows these steps:

- defining the problem (the requirement for the analysis);
- analyzing the goals of the analysis;
- selecting the elements of cost to include in the analysis and select or construct a model;
- collecting required model input data;
- runing the model, including "what-ifs" and sensitivities;
- performing analysis of model output data and developing conclusions; and
- documenting the analysis results and making recommendations.

12.4 O&S COST METHODOLOGY

Before initiating an O&S cost estimate, the methodology for the estimate must be determined. This methodology will depend on the purpose of the estimate, the system under analysis, the acquisition phase, and the data available. Using this information, a procedure for accomplishing an estimate could begin by:

- establishing a set of study objectives;
- determining the O&S cost of similar systems and budgeted or programmed O&S costs of the new system.
- reviewing, if applicable and available, the Analysis of Alternatives; and
- performing a "should cost" or cost reduction exercise.

12.4.1 Develop Ground Rules, Facts Bearing on the Problem, and Assumptions

Ground rules, facts bearing on the problem, and assumptions (where needed facts are not available) are based on the way the system will be operated, maintained, and supported in peacetime. The ground rules, facts, and assumptions include descriptions of relevant missions and system characteristics and manning, maintenance, support, and logistics *policies*. All ground rules, facts, and assumptions must be clearly stated and documented.

The intended use of the system should be determined in order to identify the pertinent support characteristics; planned logistics resources; and, in turn, the related cost. As stated in the USAMC Logistic Support Activity prepared *DoD Handbook: Acquisition Logistics* (MIL-HDBK-502), "Determining the best set of planned logistics resources for a system is the function of the acquisition logistics discipline of systems engineering. It is accomplished through analysis of those *design characteristics, which generate a need for, or are associated with, providing operational support to the total system.* These design characteristics are developed by many different disciplines pursuing a wide range of systems engineering activities. Individually they may be viewed as hardware, software, or support-system design characteristics. Collectively they represent the "supportability" of a total system." For example, in estimating O&S cost for ground-based radar system maintenance requirements, consideration must be given to the need for a 24-hour-a-day, 365-day-a-year mission. The acquisition logistics discipline of systems engineering would likely perform tradeoff analyses between system redundancy and the costs of maintenance manpower/spares required to ensure affordable mission availability is met. The O&S cost would be developed accordingly.

12.4.2 Select Comparable System

A comparable system may be an operational program with a mission similar to the proposed program. It is often the system being replaced, unless another system provides a better reference for the analysis. There are a variety of sources within each Service for obtaining technical, performance, and cost data on comparable systems. The assumptions, ground rules, and cost estimating methodologies for both the comparable and proposed systems must be related. This is essential in order to identify differences in resource consumption due to differences in system characteristics. Caution is necessary when considering data from a system acquired prior to the implementation of Acquisition Reform. Comparable system data are then adjusted to better approximate the proposed system.

12.4.3 Identify O&S Cost Drivers

System O&S cost drivers must be identified early in the system life cycle. These vary from program to program but are defined as those elements in the program that have a major impact on system LCC. As the program matures, these drivers should influence system design choices. As the design matures, O&S cost drivers will change. Alternative approaches, design tradeoffs, and sensitivity of O&S costs to changes should be evaluated within the "Analysis Of Alternatives" (AOA).

12.5 DETERMINE COST-ESTIMATING TECHNIQUE

When estimating the O&S cost of a system, there are several techniques that may be applied. The choice of technique depends on the maturity of the program and the data available. Most O&S analyses are accomplished using a combination of three estimating techniques: analogous system, parametric, and engineering. The latter is sometimes called a "bottoms up" or "grass roots" estimate and uses accounting-type data. As the program progresses from concept development to production, more-detailed cost data become available. Initial estimates are then updated with a prototype test or actual operational data. Regardless of the estimating technique applied, appropriate documentation must accompany the estimate. The following is a summary of each of these estimating techniques.

12.5.1 Analogous System

In this technique, a currently fielded system (a comparable system) that is similar in design and/or operation to the proposed system is identified. Taking the fielded system's data and adjusting them to account for any differences then develops the cost of the proposed system. The analogous system may be a composite of several fielded systems. This technique of cost estimation is widely used. One drawback to analogous system estimation is the amount of detailed technical and engineering data required. The analogous system approach places heavy emphasis on the opinions of "experts." Therefore, it is necessary to document clearly the rationale used to determine the composition of the analogous system and the adjustment factors used.

12.5.2 Parametric

The parametric approach employs Cost-Estimating Relationships (CERs) to develop estimates using regression analysis. A CER is an equation that relates one or more characteristics of an item to some element of its cost. For example, a study of existing avionics equipment may yield a CER relating avionics unit cost to the weight of the avionics system. This CER could then be used to predict avionics unit cost for a new system, which has weight that needs estimated. Normally analogy or parametric estimating is used early in the life cycle of a system, when item specific data is not known. CERs must be examined to ensure they are current (i.e., reflect acquisition reform), appropriate for the range of data being estimated, and applicable to the system. If they are improperly applied, the result could be serious estimating errors.

12.5.3 Accounting Estimates

The accounting method uses engineering estimates of reliability, maintainability, and component cost characteristics (optempo rates) to build estimates from the "bottom-up" for each cost category. Accounting estimates require detailed system data. The system is typically broken down into lower-level components, and estimates of each component are made. Although this method can be complex and time consuming, it is the method of choice when detailed system data is available.

12.6 SELECTING THE MOST APPROPRIATE COST MODEL

As with the choice of methodology, the selection of an O&S cost model also depends on the purpose of the estimate, the system under analysis, the acquisition phase, and (most importantly) the data available.

12.6.1 Desired Characteristics

Although no single O&S model can be used for all purposes, an O&S model should have as many of the following characteristics as possible:

12.6.1.1 Consistency. A consistent model conforms to current O&S cost-estimating practices. This allows the proposed system to be compared to an analogous system.

12.6.1.2 Flexibility. The model should be constructed so that it is useful in the early phases and can evolve to accommodate more-detailed information as the program continues through its life cycle.

12.6.1.3 Simplicity. The model should require only the minimum data necessary to estimate the O&S cost. More complex models can be used as more data becomes available.

12.6.1.4 Usefulness. The model should provide useful information to the decision makers in their evaluation of support and design tradeoffs.

12.6.1.5 Completeness. O&S models should include all applicable costs for a system's operation and support over its useful life.

12.6.1.6 Validity. The model should be capable of providing logical, reproducible results.

12.6.2 Cost Models in Wide Use

Three O&S cost models widely used in the DoD are the Cost Analysis Strategy Assessment (CASA) model, the Air Force's Cost-Oriented Resources Estimating (CORE) model, and the Logistics Support Costs (LSC) model. A sampling of models selected to illustrate the characteristics for a credible O&S cost model follows:

12.6.2.1 CASA. CASA is designed as an engineering estimate or accounting model. No CERs are used. The model conforms to the requirements of the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) guidelines for cost elements. The model uses some 90 algorithms and 190 variables to capture all relevant operating and support costs. It is flexible which means most of the inputs are optional so the model's capability can be tailored to the needs of the LCC analyst. Also, the model uses fixed formulas so the analysis is completely repeatable. It is general purpose and has been used in all of the Services to support analysis needs on a wide variety of systems and equipment.

12.6.2.2 CORE. CORE is designed to provide a cost-estimating technique to be used to develop aircraft O&S cost estimates. CORE uses data available from standard USAF data systems (consistency). It allows the estimating techniques to vary as the program progresses through the phases of acquisition (flexibility), and it estimates all common O&S cost elements (completeness). It uses the format, cost element structure, and procedures generally required for milestone briefings (usefulness).

12.6.2.3 LSC. The LSC uses consistent data for comparable systems available from standard USAF data sources (consistency) and also contains built in factors allowing the model to be used when little item-specific data is available. As the program matures and item-specific data evolves, the factors are replaced, which results in an improved O&S cost estimate (flexibility). The LSC model addresses spares, depot maintenance, and transportation in detail. Manpower, support equipment, and training are addressed only superficially; fuel and other costs of operation are not included in the model.

12.7 DATA SOURCES

Various sources of data are available to accomplish O&S cost estimates. As with budget estimation, which is normally based on actual contract expenditures on similar acquisitions, O&S costs come from the reporting of information from field use of similar systems. The data source will depend on the type of analysis and model being used. With the advent of widespread use of LCC in the early 1970s, the Navy began development of the Visibility and Management of Operating and Support Costs (VAMOSC) data reporting system. Over the years VAMOSC has been underfunded and repeatedly "re-engineered" as organizations and their reporting capability have continually come and gone. Each of the Services' centers for cost analysis is involved in VAMOSC-associated work. In mid-1996 the OSD CAIG and the Navy Center for Cost Analysis teamed to investigate, once again, the VAMOSC for a major re-engineering in support of the CAIV initiative. Many of their recommended improvements are already being implemented. The following are types of data drawn from VAMOSC and other Service databases. The final paragraph of this chapter lists each Service Component's cost center.

12.7.1 Comparable System Data

Comparable system data are used in accomplishing analysis before specific system details are available. The logistics manager must adjust comparable system data to reflect the changes expected in the proposed system. For example, if the proposed system incorporates built-in test (BIT) while the comparable system does not have this capability, the comparable system data on fault isolation labor-hours would have to be adjusted to reflect BIT use in the proposed system.

12.7.2 Engineering Estimates

As the system definition matures, system-specific data replaces comparable system data. System engineers are the primary source for item-specific reliability and maintainability data plus performance estimates. This data is followed by test and evaluation data and then by actual field data.

12.7.3 Usage Data

The program will need to make provision for a consistent source of logistics and other data for O&S cost analyses. The program analysis database should include specific data on costs, reliability, maintainability, training, support equipment, provisioning, packaging, facilities, etc. The program data may or may not be consistent with some Service-specific O&S cost models. Some program data may have to be adjusted to account for model definition or format differences.

12.7.4 Cost and Planning Factors

The Military Departments maintain cost and planning factors, which can be used to estimate resource requirements and costs associated with force structures, missions, and activities.

2.8 COMPLETING THE O&S COST ESTIMATE

Once the technique, model, and data are in hand, it is time to estimate and evaluate the relevant O&S costs. Applying the available data to the model selected generates an estimate. The accuracy of an O&S cost estimate is affected by uncertainties from many sources. It is important to identify and bound the scope of variables that contribute to uncertainty. Each variable should be examined independently, and cross-checks should be performed to ensure that the estimate is credible.

12.8.1 Sensitivity Analysis

To identify those element outputs that are particularly vulnerable to relatively small changes in driver input values, sensitivity analysis varies the data inputs of certain cost drivers. This analysis is performed to identify the magnitude of the uncertainty in the O&S cost estimate and to identify areas that require further management attention. Sensitivity analysis can also determine the effects of data uncertainties and changes in ground rules and assumptions.

12.8.2 Documenting the Results

Detailed documentation of the cost estimate is essential to an O&S estimate. The documentation serves as the audit trail of the ground rules, facts bearing on the problem and assumptions, estimating techniques, model selection basis, data sources, sensitivity analysis, and results. The documentation should explain the methods used to establish the bounds and the elements included in the sensitivity analysis. The documentation provides sufficient information for the replication and confirmation of the estimate by an experienced analyst.

12.8.3 Making Revisions

The O&S cost estimate is revised prior to each milestone review to incorporate all changes to the program since the last milestone or revision. Keeping an estimate current at all times is essential. Therefore, as major program changes occur, the O&S estimate is revised (even if an O&S cost impact is not readily apparent). For example, a decision to change to composite material may result in less maintenance required but more expensive repair techniques.

12.9 USES FOR THE O&S COST ESTIMATE

The O&S Cost estimate is a large part of the total program LCC. O&S cost estimates are required whenever the LCC estimate is prepared. Annual program office estimate requirements vary, but usually include O&S costs.

12.9.1 Analysis Of Alternatives (AOA)

The analysis is to aid decision makers in judging whether or not any of the proposed alternatives to an existing system offer sufficient military and/or economic benefit to be cost worthy.

12.9.2 Tradeoffs

Once a baseline estimate is complete, the impact of program changes on O&S costs can be evaluated. When combined with schedule and performance data and an objective function, the estimate may support a CAIV-based tradeoff exercise. An example of a design tradeoff is an Engineering Change Proposal (ECP). The ECP analysis is used to assess the cost implications of a proposed design change. The decision to accept or reject the ECP is made after considering the effect on program costs. Comparing the cost of the baseline configuration with the cost of the proposed configuration assesses the ECP. Areas of uncertainty are identified and appropriate sensitivity analyses performed.

12.9.3 Independent Cost Estimate (ICE)

An ICE is a cost estimate prepared by an objective nonprogram office team. The decision makers use the ICE primarily to identify any inconsistencies with the program office estimate. An O&S cost estimate is a major portion of these ICE efforts.

12.9.4 Milestone Reviews

During a milestone review, program LCC is carefully scrutinized to determine program readiness to proceed to the next acquisition phase. Both the program office estimate and the ICE are reviewed to determine if the program is still likely to meet requirements and is still cost-effective. A recommendation is provided to the decision makers following this review.

12.9.5 Source Selection

O&S estimates should be an integral part of the most probable cost for each proposal under consideration during source selection. These most probable costs are used by the source selection authority in award.

12.9.6 Budgeting

Budgeting for O&S cost elements is one use of the estimate. The current DoD trend is to track cost estimating more closely with budgeting. An effort is underway to incorporate the O&S cost estimate into the Acquisition Program Baseline (APB).

12.10 REFERENCES

1. "Acquisition Logistics," *Department of Defense Handbook* (MIL-HDBK-502), prepared by USAMC Logistic Support Activity, ATTN: AMXLS-ALD, Building 5307, Redstone Arsenal, AL 35898-7466. WEB: http://www.logsa.army.mil:80/logsa.htm

2. Service Cost Centers:

   Army
   U.S. Army Cost and Economic Analysis Center
   5611 Columbia Pike
   Falls Church, Virginia 22041
   Tel: DSN 761-3336/7/8; Comm (703) 681-3336/7/8
   E-Mail: TRMATEER@aol.com
   WEB: http://www.asafm.army.mil

   Navy
   Navy Center for Cost Analysis
   1111 Jefferson Davis Highway
   Arlington, Virginia 22202-4306
   TEL: Comm (703) 604-0293
   E-Mail: downsirene@ncca.navy.mil
   WEB: www.ncca.navy.mil/ncca.htm

   Air Force
   Air Force Cost Analysis Agency
   1111 Jefferson Davis Highway
   Arlington, Virginia 22202
   TEL: Comm (703) 604-0387
   E-Mail: WEEKS@afcaanet.afcaapo.hqaf.mil
   WEB: http://www.saffm.hq.af.mil/SAFFM/

13
LIFE-CYCLE COST (LCC)

"As to government expenditures, those due to broken-down chariots, worn-out horses, armor and helmets, *arrows and crossbows, lances, hand and body shields, draft animals and supply wagons will amount to 60 percent of the total."*

Sun Tzu, *The Art of War* (Sixth century B.C.)

13.1 POLICY

13.1.1 Broad Policy

Defense acquisition policy, as stated in DoDD 5000.1, includes the requirement to obtain quality products, "... at a fair and reasonable price." This directive, which governs the defense acquisition system, goes on to address cost and life-cycle costs in each of the three major policy areas. Requirements include the need to:

- minimize the cost of ownership in the context of a total system approach;
- view cost in the context of Cost As an Independent Variable (CAIV), recognizing that the majority of costs are determined early in a program;
- work closely with the user to achieve a proper balance among cost, schedule, and performance while ensuring that systems are both affordable and cost-effective.

The Program Manager (PM), together with the user, are to propose cost objectives and thresholds for Milestone Decision Authority (MDA) approval, which will then be controlled through the Acquisition Program Baseline (APB) process. Further, the PM is asked to search continually for innovative practices to reduce costs, including prudent investments in pollution prevention in an effort to reduce life-cycle environmental costs and liability. Finally, the acquisition community is to recognize that competition provides major incentives for industry to enhance the application of advanced technology and life-cycle cost advantages to defense programs as well as a mechanism to obtain an advantageous price.

13.1.2 DoD 5000.2-R Policy

For all Acquisition Category (ACAT) I and IA programs, a life-cycle cost estimate shall be prepared by the program office in support of program initiation (usually Milestone I) and all subsequent milestone reviews. The Component's staffing authority shall prepare a staffing estimate for ACAT I programs in support of Milestone II and Milestone III. For ACAT I programs, the MDA may not approve entry into engineering and manufacturing development or production and

deployment unless an independent estimate of the full life-cycle cost of the program and a staffing estimate for the program have been completed and considered by the MDA (10 USC §2434).

The life-cycle cost estimates shall be:

- explicitly based on the program objectives, operational requirements, contract specifications for the system, and (for ACAT I programs) a life-cycle cost and benefit element structure agreed upon by the Integrated Product Team (IPT);

- comprehensive in character, identifying all elements of cost that would be entailed by a decision to proceed with development, production, and operation of the system regardless of funding source or management control;

- for ACAT I programs, consistent with the cost estimates used in the analysis of alternatives and for staffing estimates behind the operation and support costs, consistent with the (Component's) staffing estimate.

- Neither optimistic nor pessimistic but based on a careful assessment of risks and reflecting a realistic appraisal of the level of cost most likely to be realized.

For ACAT I programs, the DoD Component sponsoring the acquisition program shall establish, as a basis for the life-cycle cost estimates, a description of the salient features of the acquisition program and of the system itself. This description, referred to here as a Cost Analysis Requirements Description (CARD), is given to the teams preparing the program office life-cycle estimate, Component cost analysis, and independent life-cycle cost estimate. The description should be prepared 180 days in advance of a planned Overarching Integrated Product Team (OIPT) or Component review, unless another due date is set by the OIPT. The CARD shall be flexible, tailored, and make reference to information available in other documents available to the cost estimators. For joint programs, the CARD shall include the common program as agreed to by participating DoD Components. For ACAT IA programs, the PM shall prepare the CARD in coordination with the appropriate IPT members.

For programs with significant cost risk or high visibility, the Component Acquisition Executive (CAE) may request that a component cost analysis estimate also be prepared in addition to the program office life-cycle cost estimate. For all ACAT I programs, the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) shall prepare an independent life-cycle cost estimate and a report for the appropriate MDA for all milestone reviews after Milestone 0.

For all ACAT IA programs, the Office of Secretary of Defense (OSD) Principal Staff Assistant (PSA) or sponsoring DoD Component shall ensure that a Component cost analysis is created for Milestone I and updated for Milestone II. The MDA may direct an updated analysis for subsequent decision points if conditions warrant. At Milestone I, the component may conduct a sufficiency review of the PM's life-cycle cost estimate in lieu of a full analysis. The IPT shall establish the content of sufficiency review.

13.2 USES OF LIFE-CYLE COST

The LCC estimate plays a key role in the management of an acquisition program. Its primary functions include providing the following information:

- major input to acquisition decisions among competing major system alternatives;
- input in requirements determination; and
- within a selected system alternative
  - — identification of cost drivers,
  - — index of merit for tradeoff evaluations in design, logistics, and manufacturing, and
  - — the basis for overall cost control.

13.3 MILESTONE DECISION POINTS AND COST

Upon approval of a Mission Need Statement (MNS), an approach shall be formulated to set and refine cost objectives. By program initiation (usually Milestone I), each ACAT I and ACAT IA PM shall have established life-cycle cost objectives for the program through consideration of projected out-year resources, recent unit costs, parametric estimates, mission effectiveness analysis and trades, and technology trends. A complete set of life-cycle cost objectives shall include Research, Development, Test, and Evaluation (RDT&E), production, operating and support, and disposal costs. At each subsequent milestone review, cost objectives and progress towards achieving them shall be reassessed.

At each milestone decision point, including the decision to start a new program, life-cycle costs, cost/performance/schedule tradeoffs, cost drivers, and affordability constraints will be among the major considerations.

13.4 COST CONTENT WITHIN THE ACQUISITION PROGRAM BASELINE

The cost parameters stated in the APB shall be limited to these costs:

- RDT&E costs,
- procurement costs,
- military construction costs,
- costs of acquisition items procured with Operations and Maintenance (O&M) funds, if applicable,
- total quantity (to include both fully configured development and production units),

- average unit procurement cost (defined as the total procurement cost divided by total procurement quantity),

- program acquisition unit cost (defined as the total of all acquisition related appropriations divided by the total quantity of fully configured end items), and

- any other cost objectives designated by the MDA, e.g., life-cycle cost objective.

All estimates are to be expressed in base-year dollars. As the program progresses through later acquisition phases, procurement costs shall be refined based on contractor actual costs from program definition and risk reduction, engineering and manufacturing development, or from initial production lots. The amount budgeted shall not exceed the total cost threshold estimated in the APB. For ACAT IA programs, the ACAT I cost parameters apply, with the addition of military pay and Defense Working Capital Fund (DWCF).

No funds shall be obligated for an ACAT I program after that program enters the Engineering and Manufacturing Development (EMD) phase or production and deployment until an APB has been approved by the MDA, unless the USD(A&T) has specifically approved the obligation (10 U.S.C. §2435(b)4).

13.5 COST/PERFORMANCE TRADEOFFS

The best time to reduce life-cycle costs is early in the acquisition process. Cost reductions are accomplished through cost/performance tradeoff analyses, which are conducted before an acquisition approach is finalized. To facilitate that process, the Overarching IPT (OIPT) for each ACAT I and ACAT IA (as required) program establishes a Cost Performance IPT (CPIPT). The user community is represented on the CPIPT. Industry representation, consistent with statute and at the appropriate time, is also considered.

Maximizing the PM's and contractors' flexibility to make cost/performance tradeoffs without unnecessary higher-level permission is essential to achieving cost objectives. Therefore, the number of threshold items in requirements documents and acquisition program baselines are strictly limited; the threshold values represent true minimums; and requirements are stated in terms of performance rather than technical solutions and specifications. The systems engineering process, system analysis, and control are established to serve as a basis for evaluating and selecting alternatives, measuring progress, and documenting design decisions. This includes the conduct of tradeoff studies among requirements (operational, functional and performance), design alternatives and their related manufacturing, testing and support processes, program schedule, and life-cycle cost. These tradeoff studies should be performed at the appropriate level of detail to support decision-making and lead to a proper balance between performance and cost. Request For Proposals (RFPs) include a strict minimum number of Key Performance Parameters that will allow industry maximum flexibility to meet overall program objectives. Cost objectives are used as a management tool. The source selection criteria communicated to industry should reflect the importance of developing a system that can achieve stated production and life-cycle cost thresholds.

13.6 COST MANAGEMENT INCENTIVES

Incentives shall be applied to both government and industry to achieve the objectives of CAIV. Awards programs (both monetary and nonmonetary) and "shared savings" programs are used creatively to encourage the generation of cost-saving ideas for all phases of life-cycle costs. Incentive programs target both individuals and teams in both government and industry. Incentives include up-front investments to minimize production and/or operation and support costs, where applicable.

13.7 ACQUISITION LOGISTICS COST

Acquisition programs establish logistics support concepts, e.g., two-level and three-level, early in the program and refine them throughout the development process. Life-cycle costs play a key role in the overall selection process. Support concepts for new and future systems provide for cost-effective, total life-cycle logistics support.

The PM ensures that reliability, maintainability, and availability activities are established early in the acquisition cycle so that operational requirements and reduced life-cycle ownership cost are met. Reliability, maintainability, and availability requirements are based on operational requirements and life-cycle cost considerations. The requirements and considerations are stated in quantifiable, operational terms that are measurable during developmental and operational test and evaluation and defined for all elements of the system, including support and training equipment. Figure 13-1 shows the dominant role that logistics plays in system life-cycle cost.

13.8 THE DEFENSE WORKING CAPITAL FUND (DWCF)[1]

As a revolving-fund financial structure, the DWCF builds on revolving-fund principles previously used for industrial and commercial-type operations. The DWCF consists of multiple divisions identified by Component and by business area. Within these business areas, there are support organizations (providers) which operate like commercial businesses by selling goods and services to DoD's operating forces and other business areas (customers).

Customer orders (funded requests for goods and service) provide the budgetary resources to finance defense business operations. Customers fund their requests primarily with appropriated resources (e.g., operation and maintenance; procurement; and research, development, test, and evaluation). Income (or budgetary resources) derived form the sale of goods and services is then used to finance the DWCF business areas' continuing operations without fiscal year limitations. Unlike profit-oriented commercial businesses, DWCF businesses strive to reach break-even prices charged to customers. Revenue from customers sustains the full cost and the continuous cycle of DWCF business operations.

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[1] Reference for this paragraph is as follows: *Defense Working Capital Fund (DWCF) Handbook,* CALIBRE Systems, Inc., Falls Church, Virginia, and Office of the Under Secretary of Defense (Comptroller), Washington, DC, 1995, pp. 1-2 to 1-4.

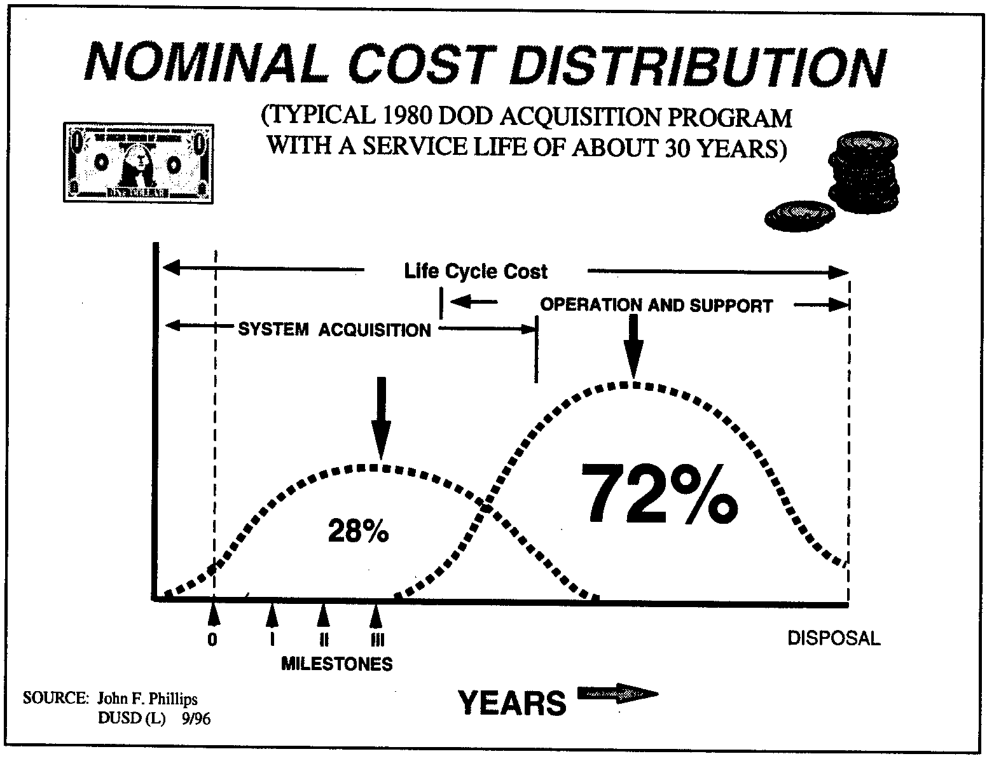

Figure 13-1: Nominal Cost Distribution

The basic tenet of the DWCF financial structure is to create a customer-provider relationship between military operating forces and support organizations.

- Customers of the DWCF business area providers include any DoD command or organization, non-DoD Federal Government agencies, and other U.S. and foreign agencies and commercial enterprises when authorized by DoD.

- Providers in the DWCF customer-provider relationship are the business areas and related support organizations that are responsible for providing goods and services to the operating forces and that are financed through the DWCF.

The customer-provider relationship is fundamental to the DWCF financial structure. The relationship has significantly increased the customer's responsibility for properly determining support requirements and the level of performance required from DWCF-financed support organizations. The result of the customer-provider relationship is a meaningful "linkage" between military mission operations and the cost to support those operations.

This linkage is a major feature of the DWCF's control process. The inclusion of previously directly financed areas in the DWCF is causing the DWCF business area operations to be financially sized (in both budget and implementation) based on their customers' requirements and appropriated resources available for DWCF goods and services. In other words, the resources required by the DWCF business area organizations to continue operations vary directly with their customers' needs for their goods and services. As the volume of customer requirements decline,

so, too, will the relative financing of a supporting DWCF business area. The significance of this linkage makes it essential for customers and providers alike to understand the nature of the DWCF financial processes and the potential impact they can have on military readiness.

In summary, the DWCF financial structure and management processes focus on total-cost visibility and full-cost recovery for the Department's support functions. The DWCF financial structure provides DoD managers with improved financial management tools and facilitates the reduction of DoD support costs through better business practices. The use of the DWCF financial structure is intended to:

- foster a business-like customer-provider approach that enables the customer to make economical buying decisions and encourages the provider to become more cost conscious;
- identify the full costs of support, measure performance on the basis of cost/output goals, and foster efficiency and productivity improvements;
- provide timely and accurate information to decision makers at all levels to enhance the decision making process; and
- more closely relate the support infrastructure with the force structure.

14

COST AS AN INDEPENDENT VARIABLE (CAIV)

"War is not, as some seem to suppose, a mere game of chance. Its principles constitute one of the most intricate of modern sciences."

General Henry W. Halleck,
Elements of Military Art and Science, Third ed. (1863)

14.1 POLICY

The acquisition strategy shall address methodologies to acquire and operate affordable DoD systems by setting aggressive, achievable cost objectives and managing achievement of these objectives. Cost objectives shall be set to balance mission needs with projected out-year resources, taking into account anticipated process improvements in both DoD and defense industries.

14.1.1 Cost/Performance Tradeoffs

Cost reductions are accomplished through cost/performance tradeoff analyses, which shall be conducted before an acquisition approach is finalized. To facilitate that process, the Overarching Integrated Product Team (OIPT) for each Acquisition Category (ACAT) I and IA (as required) program establishes a Cost/Performance IPT (CPIPT). The user community is represented on the CPIPT. Industry representation, consistent with statute and at the appropriate time, is also considered.

14.2 COST AS AN INDEPENDENT VARIABLE (CAIV)

14.2.1 Discussion

An initiative to reduce life-cycle costs of systems is called Cost As an Independent Variable (CAIV). Thus, performance and schedule are a function of available (budgeted) resources. CAIV was proposed in 1995 and implemented in March of 1996 as part of the 5000-series directives on defense weapons systems acquisition. Implementation is directed for all Major Defense Acquisition Programs (MDAPs) in Concept Development or Program Definition and Risk Reduction phases and selected programs beyond that point. The CAIV concepts will be of value to all acquisition programs and has particular application to logistics as a major driver of life-cycle costs.

Two DoD working groups have led the definition and implementation of CAIV. A Defense Manufacturing Council (DMC) Working Group developed a CAIV working group

report disseminated in December 1995, which describes a strategy for setting aggressive, realistic cost objectives for acquiring defense systems and managing the associated risks. In June 1996, the Flagship Programs Workshops began meeting under the leadership of the Office of the Under Secretary of Defense (Acquisition and Technology) (OUSD (A&T)). The participants include representatives of eight defense programs as well as representatives of the Office of the Secretary of Defense (OSD), Institute for Defense Analyses (IDA), and the Defense Systems Management College (DSMC).

Continuing this momentum in 1997, a DMC planning team recommended that the old council be sustained under a new name, the Defense Systems Affordability Council (DSAC). Under this new name, DMC work was continued, but with a new organization and a new mode of operation. DSAC's two major thrusts were to (1) continue DMC momentum on ongoing acquisition reform initiatives including CAIV and (2) conduct an integrated acquisition logistics attack on life-cycle cost. The first DSAC meeting was held 2 June 1997.

Figure 14-1 provides a listing of the eight flagship programs. Those eight programs were (1996/97) sharing problems and solutions in implementing CAIV policy. This section looks at the definitions, concepts, processes, and risks of CAIV with examples from the Flagship Programs.

14.2.1.1 Definition. CAIV is a new (1995) DoD strategy that makes total life-cycle cost, as projected within the new acquisition environment, a key driver of system requirements, performance characteristics, and schedules. This is a 180-degree conceptual change in thinking from the days of requirements, performance, and sometimes schedule-driving costs. While the life-cycle cost/performance/requirements tradeoff process is the heart of CAIV, a broader definition is necessary to recognize the environment in which these trades take place. Programs are being aggressively managed to meet program objectives concomitantly with the implementation of reform initiatives such as use of commercial specifications and practices, Integrated Product and Process Development (IPPD) Teams, and contractor enterprise re-engineering. The acquisition reform initiatives have the potential to significantly reduce cost and change the baseline against which the cost/performance/requirements trades are to be benchmarked. The description of CAIV within this broader context as provided in the *Defense Acquisition Deskbook* is, "CAIV is a strategy that entails setting aggressive, yet realistic cost objectives when acquiring defense systems and managing achievement of these objectives. Cost objectives must balance mission needs with projected out-year resources, taking into account existing technology, maturation of new technologies and anticipated process improvements in both DoD and industry." In some ways CAIV suffers from the combination of too many initiatives to be easily explained. Philosophically CAIV is the combination of all the best practices affecting cost.

PROGRAM	PROGRAM DESCRIPTION	PROGRAM STATUS
EELV	A more cost-effective space launch vehicle for medium and heavy lift requirements	Pre-Engineering and Manufacturing Development (EMD) phase, start Dec. 1996
AIM-9X	Next generation Sidewinder air-to-air missile	EMD start Jan. 1997
TACMS-BAT P31	Upgrade of tactical ground-to-ground missile – new seeker	Currently in Program Definition and Risk Reduction (PDRR), EMD start in 1998
MIDS	Third generation secure, jam-resistant, communication system for NATO family	EMD contract awarded in Mar. 1994; restructured June 1994; CDR in-process
JASSM	Long-range air-to-surface standoff missile	Entering 2-year competitive PDRR
CRUSADER	155MM self-propelled Howitzer and armored re-supply vehicle	Completion of PDRR in FY 2000; single contract team
JSF	Advance Strike Fighter Aircraft	Pre-PDRR
SBIRS	Space-based infrared surveillance system for missile defense	Entered EMD for GEO in FY 1996; PDRR for LEO with MS II in FY 1999

Figure 14-1: CAIV Flagship Programs
(As of 21 October 1996)

14.2.1.2 Concepts. The implementation of CAIV requires new thinking about program management. If cost is truly to be the key driver of performance and schedule, no single cost-reduction strategy is likely to be sufficient. All cost-reduction initiatives must be considered. In a presentation by the Institute for Defense Analyses at the Flagship Workshop in July 1996, a hierarchy of CAIV cost levers was proposed. All of these levers are important in CAIV implementation. They are discussed below in rough order of potential benefit for most programs:

- Cost/performance/requirements trades. This is the essence of CAIV and will be discussed in detail in following sections.

- Acquisition strategy. Competition is the greatest lever to ensure that CAIV objectives are met that the government has in the early stages of a program. Because of this, competition should be maintained as long as economically practical.

- Concurrent engineering/IPPD. To meet an aggressive cost target, it is critical that all functional planning be integrated and that team members cooperate to resolve difficulties early.

- <u>Contractor enterprise re-engineering</u>. The lean enterprise philosophy encourages industry to concentrate on core capabilities and to develop long-term relationships with key suppliers for non-core activities. It also requires that core activities be conducted with maximum efficiency.

- <u>Commercial specifications, practices, and components.</u> Acquisition reform has enabled use of commercial specifications and practices in many areas. The use of commercial components, where technically feasible, is an important cost reduction tool for many programs.

DoD is striving for cost savings from these "cost levers," which will enable 50 percent and greater reductions in cost from the old way of doing business. The Joint Direct Attack Munition (JDAM) program is a frequently cited example of a program, which is achieving this magnitude of reduction from the broad impact of the new way of doing business.

Figures 14-2 is a straight-forward schematic of the CAIV process, displaying the essentials of what would otherwise call for a complex "wiring" diagram of affordability analysis, cost analysis and engineering, and cost management.

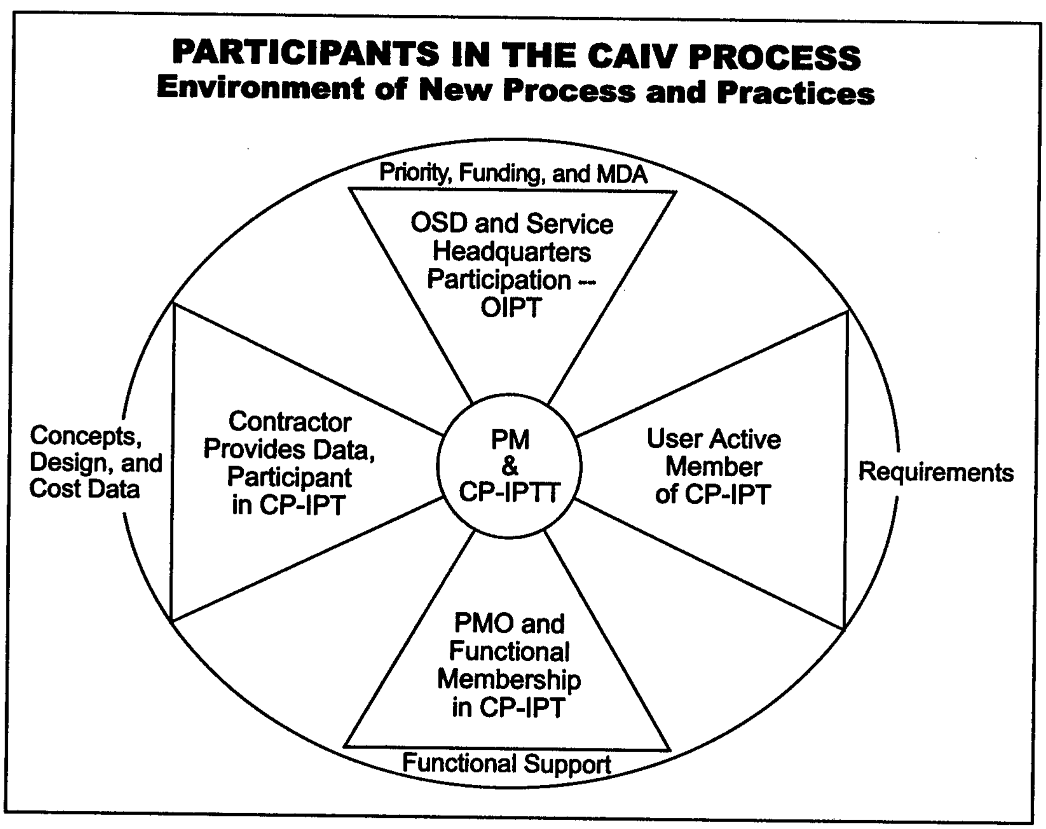

Figure 14-2: Participants in the CAIV Process

14.2.2 Trade Space

The preceding has consistently addressed the tradeoff process as cost/performance and requirements as a way of emphasizing the role of the user and the importance of the transition from the requirements process to contracting for system performance goals. This emphasizes the different nature of requirements as the system changes. To enhance the effectiveness of CAIV, programs should minimize the number of system performance parameters stated in the Operational Requirements Document (ORD) at Milestone (MS) I. This allows for the development of performance objectives that are achievable and affordable based on actual development and additional analysis during PDRR. If the minimum number of parameters is used consistently to meet the users real needs, greater leeway will be provided for future tradeoffs. The system performance parameters called out in the ORD are designated key performance parameters and are not tradable below a threshold value. For these key performance parameters the trade space exists between the threshold value and objective value with both values stated in the ORD and in the Acquisition Program Baseline (APB). These values are refined by MS II and become part of the system design specification.

For technical performance parameters, the CAIV threshold and objective values should be the same as those in the APB. For CAIV cost threshold and objective values, potential problems may exist because they are equivalent to the APB values. The program budget cannot exceed the APB cost threshold and the cost threshold is specified as 10 percent above the objective value [per 5000.2R, part 3.2.1 and 3.2.2.2]. This may provide little cost room to solve technical performance parameter breaches.

14.2.2.1 <u>Performance</u>. To some extent previous attempts at cost/performance trades have been the victims of inflexible requirements from the user or over-specified requirements by the acquirer. Performance goals have frequently been driven by available technology because the contractor and Program Management Office (PMO) are striving for "the last ounce of performance." The threshold and objective values for key performance parameters should be developed initially as the user translates the broadly stated mission need from the mission area analysis into a system description for the ORD. An analysis of alternative system concepts should be focused on determining the appropriate technical performance trades prior to the initial ORD and APB at MS I. These parameters are stated in the initial ORD and APB and updated at each milestone. For effective contracting, performance must be stated as overall system performance goals, including logistics performance goals. Performance must not be detail specific, quantified, or stated in "how to do it" parameters. In all cases, the user and acquirer must be willing to accept lesser performance to maintain or control cost within the trade space. Changing the culture regarding lesser but acceptable performance is critical to successful implementation of CAIV. Thus, the user must be an integral player throughout the process as the cost-performance/schedule/requirements tradeoffs are made in each phase of the life cycle.

14.2.2.2 <u>Early Cost Estimates</u>. Clearly the tradeoff process is more effective if it can be accomplished earlier in the design process. A large percentage of the cost is determined by a small percentage of the design decisions. These critical cost-driving design deci-

sions normally occur very early in the concept selection and design process. Because of this, greater success is expected when implementing CAIV for programs in the Concept Exploration or Program Definition and Risk Reduction phases. There are significant problems estimating production and Operating and Support (O&S) costs this early, but these estimates can be updated and improved over the life cycle. Improvement of these estimates will have the greatest program impact if competition continues.

14.2.3 Design-To-Cost

How is CAIV different from Design-to-Cost (DTC)? This question is frequently asked in discussions on CAIV. CAIV embodies more than the tradeoff process that is DTC, and there are key conceptual differences. Under CAIV the user is an active participant in the tradeoff process throughout the life cycle. This was not the case with DTC. Another key difference is a more flexible requirement based on threshold mission effectiveness. Earlier planning in the life cycle with an iterative refining of the objectives by the user and acquirer is another difference. In the past DTC has been predominately a contractor's process executed during the system design. In simplest terms, consider DTC as one of the tools for the implementation of the CAIV concept.

14.2.4 Process

The DoD initiative on Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPT) is central to the implementation of CAIV. This initiative is expected to be implemented within both the contractor and government organizations. Under the direction of the government Program Manager (PM), a CPIPT will establish the program cost objectives and facilitate the cost-performance-requirements tradeoff process. From the outset, this team's membership will include the user; contractor representation is allowed if determined to be appropriate [see 5000.2R, part 1, section 1.6]. Other members will vary depending on the phase of the life cycle, but membership could include the Service cost center and the OSD Cost Analysis Improvement Group (CAIG) as does the Joint Air-To-Surface Standoff Missile (JASSM) program. A detailed discussion of the membership and roles of the CPIPT is provided in the "Life-Cycle Cost-Performance Concept Paper."[1]

The CAIV process is an iterative one focused around the PM and CPIPT. The PM and CPIPT work with the overarching-IPT representing the PEO, Service headquarters, and OSD to determine funding, receive programmatic direction, and provide program status. The PM and CPIPT must have a strong working relationship with the user community in establishing cost-effective requirements and determining priority. The PM and CPIPT have a number of supporting acquisition organizations ranging from functional support organizations within the component command to Service cost centers providing cost estimating and analysis. Design and cost analysis by the contractors provide the CPIPT with the information necessary to analyze cost/performance tradeoffs. This circle of relationships around the PM and CPIPT enable a sequence of activities necessary to accomplish CAIV. These activities include the development of aggressive and affordable

[1] Attachment to Under Secretary of Defense memo of 19 July 1995, Subject: Policy on Cost-Performance Trade-Offs.

cost goals, implementation of incentives to encourage the accomplishment of these goals, and measurement of specific CAIV performance through tracking of metrics. Metrics can include life-cycle cost components such as Program Acquisition Unit Cost (PAUC), Average Procurement Unit Cost (APUC), Average Unit Procurement Cost (AUPC), and technical metrics such as Mean Time Between Failures and Mean Time To Repair.

14.2.4.1 Setting Aggressive Cost Targets. Aggressive cost goals are developed considering a number of elements including available resources, costs of comparable systems and components, mission effectiveness studies, technology based trends, and the use of such initiatives as lean manufacturing and commercial business practices. The CPIPT must use these elements to develop initial aggressive cost goals while balancing issues within the following framework:

(1) Using affordability as the key criterion, the Service headquarters divides a fixed budget among competing programs. Here the cost goals are used in developing a budget required for that program, which is compared with the available dollars in the POM years and based on the priority level established by the Service, JROC, and others. This fixed-budget, which is based on the priority of the program, is the reality of what is available for structuring the program. The current budget may be less constraining in the out-years, but it still drives the program acquisition strategy.

(2) Using mission effectiveness as the key criteria, the user and Service headquarters must determine "the most bang for the buck" of the proposed system. Here analytical studies begin with mission area analysis and analysis of alternatives, and they result in a set of requirements in a Mission Need Statement and Operational Requirements Document. This analysis would look at the proposed program in terms of mission effectiveness versus performance requirements and performance requirements versus cost. There are different DoD organizational elements involved in this analysis, depending on the Service: Center for Naval Analyses (Navy), TRADOC (Army), Air Combat Command (Air Force), and OSD Program Analysis and Evaluation (PA&E). These studies provide the necessary tie between mission requirements, performance parameters, and the cost-effectiveness required of the system.

(3) The PMO would normally have access to independent research and contract studies by contractors that provide concepts and cost estimates for achieving the required system performance requirements. These concepts and associated costs may vary widely from one study to the next, but they provide the critical contractor perspective on the range of alternatives and also provide key data to the above-mentioned analysis of alternatives and funding exercises.

Through the CPIPT, the PM must find a set of initial cost goals that provide an affordable budget and still enable the system to meet at least the threshold requirements of the user. If the cost goals include consideration of the most likely cost of the performance and schedule requirements, a legitimate trade space for cost/performance tradeoffs can exist

and the cost targets can have the necessary realism to be effective. If initial realistic cost goals cannot be developed through this trade program within the budget affordability, the program is not viable. The initial cost goals will be refined at each stage of development to ensure a balance between realistic and aggressive. They will be referred to as cost goals by MS I, as cost targets by MS II, and firm cost targets by MS III.

The key cost targets focus on unit production costs and operations and support costs. The AUPC may be defined in several ways. Some programs such as JASSM and AIM-9X have "bumper-to-bumper" warranty cost (although for differing periods) included in AUPC; others have no warranty cost. Further complicating this definition is the need to specify the AUPC of the total planned production and the average value for each production lot. The second area of cost focus is O&S costs, which are even more difficult to predict. Contractually, operations and support costs may best be handled, as several of the Flagship Programs have, by setting aggressive goals for key performance parameters that drive O&S costs, such as Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR).

14.2.4.2 Implementation of Incentives. The implementation of incentives is a critical part of ensuring the necessary changes. These incentives can be either positive, for achieving targets, or negative, for failure to meet targets. If the contractor is not meeting the program cost targets, an acquisition strategy could be structured to restart competition. An acquisition to provide the optimum level of competition by phase is one of the most effective ways to ensure cost is minimized. Flagship program examples are the JASSM and EELV Programs, which use rolling down-selects with the final development contract competition. These example programs include low-rate initial production and the incentive of continuation in a sole source mode as long as the final cost targets structured during the final competition are not breached.

In many programs the quantity or other factors prevent the ability to have competition in production. In these situations, the use of award or incentive profit can play a major role. The Crusader Program is an example of a program with a sole source contractor in development through procurement. In this case, the award fee is being used significantly to motivate contractor performance. This is in an environment of minimal mil-specs, mil-stds, and Contract Data Requirements Lists (CDRLs). The Space-Based Infrared Systems (SBIRS) Program uses an incentive fee to share the cost savings between government and contractor. An important motivational aspect for all programs is the shared decision role through participation on the CPIPT.

14.2.4.3 Earned Value. In the case of contracts requiring compliance with DoD Cost/Schedule Control Systems Criteria (C/SCSC) or Cost/Schedule Status Report (C/SSR) requirements, Program Managers and their IPTs should review contractor planning baselines within six months after contract award. The government's review

of a contractor's performance measurement baseline is known as an Integrated Baseline Review (IBR). The objectives of the IBR are to:

- ensure that reliable plans and performance measurement baselines are established, which (a) capture the entire technical scope of work, (b) are consistent with contract schedule requirements, and (c) have adequate resources assigned to complete program tasks;

- improve the use of cost/performance data by government and contractor program managers as a management tool; and

- reduce the number of C/SCSC management systems reviews based on insights developed through assessment of the contractor's actual implementation of their management system and processes on the instant contract.

14.2.5 Measuring Performance through Tracking of Metrics

There is a necessity for validated cost models to track life-cycle cost during program execution. The government should have access to the contractors' models and methodology. This does not mean the government and contractor have the same models, but they work together to share and validate. The contractor's design-to-cost system must provide a flow-down of the APUC to the engineering design level, with status reporting, corrective actions, and trend analysis. The reporting process must be made a part of the contract statement of work. The Crusader Program found that the models used for trades were inadequate for cost tracking. The AIM-9X Program found that it was extremely valuable to establish a Government/Contractor APUC Working Group early. Another aspect is maintaining an APUC baseline so the APUC can be re-baselined to account for government-directed design changes, quantity changes, and economic price adjustments. Any change in the baseline must be directly traceable so that the cause and magnitude are documented. Please note the prior discussion of integrated baseline reviews (14.2.4.3).

With regard to the operations and support costs tracking process, it has been handled by the Flagship Programs in one of two ways. On those programs where the contractor has provided a warranty as part of the APUC, the government needs to be concerned only with the cost models at the time of warranty negotiation. Where there is no warranty, the system is measured through test and analysis of the technical parameters driving O&S costs, such as MTBF, MTTR, and staffing requirements. Technical performance measurement should be used to track all critical performance parameters including those driving O&S costs.

14.2.6 Summary

CAIV is the key strategy in the management of all system acquisitions in the Department of Defense. The ability of the CAIV concept to achieve significant savings will be demonstrated in the Flagship Programs. However, it will take some time before results are available (early 1997 and beyond). In the meantime, all major defense acquisition programs

in the first two phases of the life cycle were charged with implementing this concept and were required to submit a paper on CAIV implementation by July 1, 1996. These programs continue to annually report progress on this concept to their Milestone Decision Authority. This chapter is largely based on reference (g) below.

14.2.7 Points Of Contact/References

a. OUSD(A&T), Principal Deputy Director Strategic and Tactical Systems, telephone 703-695-7417.
b. Defense Systems Management College, Faculty Division, telephone 703-805-3683.
c. Program managers referenced in Figure 14-1.
d. *Defense Acquisition Deskbook.*
e. Kausal, B. A., "Controlling Cost – A Historical Perspective," *Program Manager,* November-December 1996, Defense Systems Management College, Fort Belvoir, Virginia.
f. Land, Gerry, "Cost As an Independent Variable (CAIV) Philosophy," unpublished e-Mail text, July 1996, Defense Systems Management College, Fort Belvoir, Virginia.
g. Rush, Benjamin, "Costs as an Independent Variable: Concepts and Risks," *Acquisition Review Quarterly,* Spring 1997, Defense Systems Management College, Fort Belvoir, Virginia.

15

LOGISTICS PROGRAMMING AND BUDGETING

"General, (Alain C. Enthoven to a senior USAF officer in Germany), I don't think you understand. I didn't come for a briefing. I came to tell you what we have decided."

Henry L. Treewhitt, *McNamara* (1971)

15.1 OVERVIEW

DoD acquisition programs have historically operated within an interlocking set of three decision-making systems:

- The *requirements generation system,* where program requirements are originated, validated, and assessed for Service "jointures" potential;
- The *acquisition management process,* where programs are periodically reviewed and management decisions are made concerning program progress through the acquisition phases; and
- The *Planning, Programming, and Budgeting System (PPBS),* where program funding is managed.

The ability of the Program Manager (PM) to interface effectively with these three systems is essential to program success.

This chapter deals with one subset of the PPBS. This subset involves developing the acquisition logistics manager's input to the program office's portion of the Service's Program Objective Memorandum (POM); and the acquisition logistic manager's input to the Service's Budget Estimate Submission (BES) as part of the biennial budget process.

Many logistics managers have documented logistics support planning, and many others have documented contracting documents to execute the plans. However, the truly successful logistics managers have effectively documented and defended the logistics portion of the POM and budget. These are the people who have the resources to properly execute the plans.

15.2 PROGRAM COST CATEGORIES, COST OBJECTIVES, AND COST PERFORMANCE TRADEOFFS

Program management personnel will work with the user (see DoDD 5000.1, paragraph C.9) to identify systems performance and schedule requirements, perform cost related tradeoffs, and set objectives for all relevant cost categories. Once these performance, schedule, and cost objectives have been set, the acquisition process will make cost more of a constant and less of a variable, while nonetheless obtaining the needed military capability of the system. In this regard, see Chapter 14, Cost As an Independent Variable (CAIV).

Several programs, both recently and in the past, have employed CAIV principals. However, until recently, DoD's goal-setting processes have been largely driven by an unrelenting threat (requirements creep to match a changing threat) and a desire to capitalize on technological advances. This trend toward program requirement creep, in lieu of emphasizing cost/performance/schedule tradeoffs in goal setting and management, has contributed to a historical cost-growth record for DoD programs. Research has shown that virtually all 700 acquisition programs have experienced cost growth over the past 25 years. The objective of the CAIV initiative is to ensure that constant management attention is focused on controlling costs associated with both new and fielded DoD systems.

15.2.1 Cost categories

There are several ways costs associated with a program must be defined and estimated, they include funding appropriation, work-breakdown structure, and Life-Cycle Cost (LCC) categories. These are defined below:

15.2.1.1 Breakdown by Funding Appropriation. These include Research, Development, Test, and Evaluation (RDT&E); Procurement; Operations and Maintenance (O&M); Military Construction; and Military Personnel. These breakouts are necessary to develop internal budgets and for budget requests to Congress.

15.2.1.2 Breakdown by Work Breakdown Structure (WBS). The WBS is a tool used to specify work to be done and the associated costs to perform the work. Military Standard 881B provides a recommended WBS for various program categories including aircraft, ships, armored vehicles, etc. It accommodates prime mission equipment, systems engineering, program management, systems test and evaluation, training, peculiar support equipment, data, operational site activation, initial spares, initial repair parts, and industrial facilities. Each of these categories is further broken down into indentured levels of detail. This method provides an organized, structured system of compartmentalizing work and its associated costs. It facilitates detailed visibility into those parts of the work that are expected to be the major consumers of resources. Further, the method tracks the contractors' actual work performance against their initial cost estimate by specific task, i.e., work packages. The progress of the contractor's work can be reported within the

WBS structure. The historical files from the various projects and programs in Service organizations form a wealth of data from which to estimate similar future projects.

15.2.1.3 Breakdown By Life-Cycle Cost Categories. The breakdown includes Research and Development (R&D), Procurement, Operations and Support (O&S), and disposal. Although the names of these categories are similar to the DoD appropriations, they are not the same and have different meanings. These costs are addressed in Chapter 12, Logistics Cost Estimating, paragraph 12.2.1.1.

Note that LCC includes all WBS elements; all appropriations; all costs, both contract and in-house, for all cost categories.

15.2.2 Cost Estimating Techniques

This topic is addressed in Chapter 12, Logistics Cost Estimating, paragraphs 12.4 and 12.5.

15.3 COST DRIVERS

Definitions of cost estimating terminology would not be complete without including the frequently used term "cost driver." A cost driver is a program, system characteristic, or parameter that has a direct or indirect effect of changing cost. A cost driver may even be another cost element. Examples of cost drivers include numbers of systems, numbers of operating sites, numbers of systems failures, time to fix broken systems, etc. The cost of operations and support is driven by the cost of individual spare parts and by the labor-hour costs of operators and maintainers. Thus, costs sometimes drive other costs. In some instances the term "cost drivers" means all parameters and characteristics that drive costs; but, in some cases, the "cost drivers" is intended to differentiate the parameters/character-istic with the most impact on costs. Communication and documentation on common definitions of terms, ground rules, and assumptions in cost estimating is an absolute necessity.

15.4 PROGRAM MANAGER'S ROLE IN THE PROGRAM OBJECTIVE MEMORANDUM (POM) PROCESS

Programming and budgeting for the development, production and logistics support for a defense system must be accomplished within the framework of the DoD PPBS. All acquisition programs are based on identified, documented, and validated mission needs. Mission needs result from ongoing assessments of current and projected capability. After the Joint Requirements Oversight Council (JROC) validates the mission need for an Acquisition Category (ACAT) I program, the Under Secretary of Defense (Acquisition and Technology) shall convene a Milestone 0 DAB to review the Mission Needs Statement (MNS); identify possible materiel alternatives; and authorize concept studies, if they are deemed necessary. For ACAT IA programs, the JROC or the cognizant Office of the Secretary of Defense Principal Staff Assistant (OSD PSA) validates the mission need and process integrity in compliance with DoDD 8000.15. The Assistant Secretary of Defense

(Command, Control, Communication, and Intelligence) convenes a Milestone 0 Major Automated Information System Review Council (MAISRC). Similar parallel actions apply to other ACAT levels. A favorable Milestone 0 decision moves the effort into Phase 0, Concept Exploration; but it does not yet mean that a new acquisition program has been initiated. During this phase, RDT&E "study money" is allocated by the applicable Service or the Office of the Secretary of Defense (OSD) for development of the initial analyses, studies, and preparation of early documentation of alternative concepts. Also during Phase 0 activity, the initial program cost estimate is prepared and submitted into the POM process. After the program is approved at Milestone I, the sponsoring Service assigns a Program Element (PE); and, from that time, the program's POM funding levels are separately tracked by that PE in the Service and OSD databases. The program's BES is submitted by appropriation. The PM has primary responsibility for preparing the POM input and BES for the acquisition logistics requirements identified in the logistics planning documentation. The process of submitting the BES will be discussed in paragraph 15.6.

15.5 LOGISTICS FUNDING PROFILE

The information needed to develop the logistics support portion of the PM's budget comes from the many logistics functional elements. Effective logistics budgeting and funding comes from the acquisition logistics manager's understanding of the information needed, who will provide it, and how to document it as usable input to the PM's budgetary documentation. Beginning with program initiation, the acquisition logistics manager will gather and document costing information consistent with the elements as spelled out in the logistics planning documentation. Logistics support cost data are generally displayed in a document called a logistics funding profile. This profile shows the budget requirements stratified in the logistics areas listed below. The amount of detail shown in the logistics funding profile depends on the level of management attention required to keep the program funding risk to a minimum. Generally, the amount of detail should match the level of detail of the logistics element milestones in the acquisition logistics planning documentation. For each activity shown in the logistics milestone charts there should be a corresponding cost entry in the funding profile.

The logistics funding profile should have a section for each element of logistics as they are discussed in the logistics management plan. Additionally, the logistics funding profile should provide a summary by funding appropriation, a summary of program description, and the assumptions upon which the budget is based. Costs in each of the elements described below will be based on an appropriate method of cost estimating linked to Acquisition Reform initiatives including analysis by the program office.

15.5.1 Maintenance

This element is for actual repair-type maintenance as established by the system's maintenance plan. The various subelements of maintenance include requirements for depot and intermediate investment costs, test-bed facilities investment, repair costs including depot and intermediate repair, and support/training-related repair. Particular emphasis is now

required in the area of contractor maintenance services. Some special analysis studies and plans may sometimes be included. Investment costs for maintenance should not duplicate requirements identified in other areas, such as support equipment and computer resources support. Primary plant equipment that is unique to depot or intermediate repair facilities should be included as investment costs. Past experience from contracting for maintenance and from the Visibility and Management of Operations and Support Cost (VAMOSC) database may be applicable as source information on maintenance.

15.5.2 Technical Data

This element normally refers to costs associated with purchasing operator and maintainer technical manuals and depot repair standards. Additionally, this element includes requirements for the development, in-process review, production, validation, verification, distribution, and updating of technical data and the associated data records. It also includes management, review, and source data. Specific subelements to be considered are technical orders/manuals and associated changes, technical orders/manuals management, drawings/reprocurement data, planned maintenance system requirements, analysis, studies, plans, and other. Sources of information upon which to base the estimate are analysis, past contract, and field activity tasking orders. It is not unusual to see back-up data, which differentiates between the cost of technical data pages in categories such as pure text, text and graphics, lists of information such as parts lists, and paper copy as compared to electronic methods. Further breakout details are also common, including operation manuals versus maintenance manuals; manuals for organizational, intermediate, and depot; and/or breakouts for structural, electronics, and propulsion.

15.5.3 Supply Support

This element summarizes funding requirements for spares and repair parts. Requirements for spares for training hardware and peculiar support equipment and outfitting buy-outs for aviation programs should also be considered. Specific subelements to be considered are development/test spares and repair parts; interim/initial spares and repair parts, including depot and intermediate maintenance support stocks; on-board repair parts; contractor support spares and repair parts; site outfitting, replenishment spares and repair parts; supply plans and analysis; and other. These cost requirements should be consistent with supply support planning data and provisioning requirements. Sources of this information include both the program office analysis in view of Acquisition Reform initiatives, past contracts, and the many contracts awarded and managed at the supply centers.

15.5.4 Support Equipment

Support equipment (SE) cost requirements should be projected for all planned levels of maintenance, test sites, training sites, etc. Specific subelements to be considered are common support equipment; automated test equipment, including test program sets, tools, jigs and fixtures; calibration standards; support equipment support acquisition; analysis, plans; data; etc. The primary source of data is past program contracts. But SE is

provisioned in the supply system, and inventory control point contracts are also regularly used sources.

15.5.5 Computer Support Resources

This element summarizes the requirements for computer resources for the post-production software support of materiel systems. Data, compilers, hardware, and sometimes unique training required to set up the Software Support Activity (SSA) are covered here. Other specific subelements are software support, software support-associated hardware, computer development, software documentation, independent testing, support software, and simulation support. These should coincide with the computer resources planning documentation. Sources for this estimating data are past contracts for software support, which may include both prime contractors and other related contracts and field activity tasking orders.

15.5.6 Facilities

This element includes military construction, operations and maintenance minor construction appropriation costs, public works/facilities engineers, and utility requirements. Specific subelements include military construction planning and design, military construction, operation and maintenance minor construction, unspecified minor construction, facilities engineering/public works support, utilities, facilities analysis and plans, and other. Past contracts with weapons systems original equipment manufacturers rarely include lines for military construction. Contract information from separate agencies, such as the claimant civil engineering departments or, in the case of the Navy, the Naval Facilities Command, will be the sources of planning and cost-estimating data.

15.5.7 Training and Training Support

All training course requirements from development to instructor services are part of this element, including training equipment, aids, and training simulators. Specific subelements are training courses which include development, initial and/or contractor training services, technical training equipment, training devices/aids, analysis and studies, training equipment installation, engineering technical services, etc. These requirements must coincide with the applicable tasking in the training master plan. Past contracts often include lists of individual training devices and their costs.

15.5.8 Acquisition Logistics Management

This element covers all management activities for the entire logistics program, which includes supportability analyses costs not covered under deliverables for other elements shown above. Subelements could include management, Level of Repair Analysis (LORA), Reliability Centered Maintenance (RCM), studies and plans, etc. Thus, all of the logistics performance needs generally defined as maintenance planning or acquisition logistics management could be addressed in this section.

15.5.9 Related Programs

Related programs include requirements for all other support estimates under the PM's purview. Specific subelements include configuration management, installation, handling equipment, containers, packaging, handling, storage, transportation, and hazardous materiel control and management. Identification should be made of any other support-related activities, such as contractor or government laboratories and field activities that require DoD resources in any acquisition phase. Additionally, events such as special maintainability demonstrations, logistics demonstrations, maintenance engineering conferences, etc. that the acquisition logistician is specifically sponsoring (or otherwise wants budget visibility for), should be included in this portion of the funding profile. Sources of estimating data are generally historical contracts and program office analyses in view of Acquisition Reform initiatives.

15.6 THE BUDGET FORMULATION PROCESS

In ideal situations the full membership of the acquisition logistics team will be involved in the budget development process. At times it may be necessary for the acquisition logistics-integrating individual or lead logistician to create the initial draft of the logistics funding profile and to circulate it for coordination and correction among his team. The process starts with a call for the budget input from the program office financial manager. However, the budget call starts earlier from higher authority; and the calendar of budget events can be determined in advance. Typically, the budget call will forward program-level budget planning information. The planning information includes the program description, continuing development activities, numbers or schedules for systems procurements, delivery sites, user site stand-ups, planned operational tempos (repair items and manpower numbers and costs), and similar information. The logistics cost estimator must add three other items of planning information. These items are program office planning information (para 15.4), logistics element planning information (para 15.5), and user scenario-related information.

Each logistics element cost is estimated for each of the years covered in the budget call. The cost-estimating "back-up" is documented. The back-up is the methodology, data sources, ground-rules, assumptions, calculation methods (model or formulas), etc., used in calculating the budget. The budget profile, or spreadsheet, is documented showing appropriation summaries; and the budget back-up books/files are created. The budget is coordinated with the logistics element members of the IPT, and the approved logistics budget is submitted to the program financial manager. It should be noted that documentation of budget back-up is an essential step in the process. Parts of this information may or may not be forwarded with the budget inputs to the program financial manager. This documentation is especially critical in view of the likelihood of personnel turnover during the life cycle of a weapons system acquisition. The back-up information makes future adjustments to the budget, in response to budget drills, a matter of recalculation rather than starting from a clean slate.

The inputs from all of the program functional elements, such as the systems engineers, production managers, testers, logisticians, etc., are consolidated by appropriation summary. The program budget submission is then ready for submission through the levels of the Components' comptrollers; OSD-sponsoring offices and comptrollers; and, finally, to the President's budget. At the program level there are generally four appropriations "one liners;" they are total program funding for RDT&E, Procurement/Production, O&M, and Military Construction (MILCON). Even though most of the O&M and all of the MILCON are user or claimency inputs to the budget, they are shown on the program budget for continuity. The program manager needs this total program cost visibility to properly advocate the interrelated requirements.

The budget inputs are updated nearly continuously because of the biennial budget process, budget cuts, and program changes in schedule from many sources. The program financial manager regularly requires very quick turnaround to budget drills. The experienced acquisition logistics manager anticipates this requirement and has sufficient budget back-up information ready to make adjustments, prepare impact statements for the changes, and forward the re-submittal.

15.7 DOCUMENTING THE LOGISTICS FUNDING PROFILE

Individual DoD organizations may impose locally standardized budget documentation formats. The Army has required submittal of budget information in a spreadsheet format called the ACET model. The model is more of a spreadsheet-reporting format than it is a model since each organization develops and programs algorithms into the spreadsheet. The Navy has used the Logistics Requirements and Funding Plan (LRFP) and its variations for over ten years.

The most useful logistics funding profiles are those that the individual integrating logistician has developed to satisfy requirements for managing the acquisition logistics program. There is usually a very close match between the level of detail in the logistics planning document and its companion document—the logistics funding profile. Complex programs will frequently require logistics element plans containing milestone detail to the fifth or sixth level of indenture. This reflects the level of management attention intended by the lead logistician. Every milestone and activity described in the logistics plan will require funding resources for execution of the plan.

For example, under the facilities element, there may be a milestone for a site survey at the training location in a given month during the EMD phase and another milestone for a site survey for each of the gaining organizations during succeeding quarters of that phase. One would expect that each of the activities would be described in the logistics plan and that the funding requirements for each of the site visits would be evident in the logistics funding profile. The logistics funding profile is provided to the program budget/financial manager for consolidation into the overall program budget submission.

Logistics budget back-up documentation is of utmost importance. This back-up documents the justification, rational, estimation methodology, ground rules and assumptions,

formulas, cost estimating relationships (CERs), etc., used to come up with the dollar values for each logistics cost element. Because there are numerous people who participate in the budget formulation exercise and frequent and regular turnovers of the budget formulation team members, the back-up is an absolute necessity. The almost constant drills associated with defending, adjusting, and resubmitting the budget and the ease with which this is accomplished will be directly proportional to the completeness of the budget back-up documentation.

16

COST ANALYSIS STRATEGY ASSESSMENT MODEL (CASA)

Logistics We Holler
Costs Many a Dollar,
So Leave It to Last
'Cause We're so Short of Cash.
Anon.

16.1 OVERVIEW

The Cost Analysis Strategy Assessment Model (CASA) was developed by the Defense Systems Management College (DSMC) in response to a broad range of requirements gathered from many of the Services' acquisition program offices. Over the past several years the model has been validated and used successfully by all of the DoD Services, industry contractors, and other government agencies such as the Federal Aviation Administration (FAA) and the National Oceanic and Atmospheric Administration (NOAA). The model has evolved to the current 3.01 version and more enhancements are planned as user requirements evolve.

This article is designed to acquaint the reader with a useful, general purpose Life Cycle Cost (LCC) model, to announce that the model continues to be available, and that model upgrades are planned. The article summarizes the PM's need for a LCC model, discusses what constitutes a useful model, and specifically describes the CASA model.

16.2 THE REQUIREMENT FOR AN LCC MODEL

The PMs need a tool that will focus the efforts of the Integrated Product Team (IPT). They need a concise method of assuring themselves, program management, and decision-makers at all levels that reasonable decisions are being made. A review of the policies, definitions, and objectives of Systems Engineering (SE) and Acquisition Logistics in DoD 5000.2-R will lead to the conclusion that an effective system support program is one that provides support and achieves the user's readiness requirement(s) using the most life-cycle cost-effective approach. The bottom line of the PM's efforts must focus on these two key quantifiable requirements: maximized mission readiness and minimized total cost.

The PM must ensure that the LCC factors are developed in a timely manner and that they influence system design and systems engineering processes during all acquisition phases. In accomplishing this goal, the PM needs a comprehensive, accurate, and current LCC

estimate to support each management decision where cost is significant. There are few decisions made during a program's life cycle that do not affect LCC. An LCC estimate should have sufficient accuracy to permit comparison of relative costs of design and acquisition alternatives under consideration by management. In other words, LCC is a decision aid; and the LCC estimate should capture enough of the total ownership costs to facilitate well-informed decisions. The two main goals of LCC analysis are to: (1) identify the total cost of alternative means of countering a threat, achieving production schedules, and attaining system performance and readiness objectives and (2) estimate the overall cost impact of the various design and support options.

The decisions with the greatest chance of affecting LCC and identifying savings are clearly those impacting acquisition and Operating and Support (O&S) costs that are undertaken in the early stages of system development (concept exploration, program definition, and risk reduction phases). But, this does not imply that LCC tradeoff analyses are not useful during later program phases. During the production, deployment/fielding, and operational support phase, the evaluation of actual readiness data and resource consumption information, which are taken from maintenance data collection systems, regularly lead to identification of "bad actors" in need of corrective actions, such as improved reliability through an Engineering Change Proposal (ECP).

16.3 CHARACTERISTICS OF A USEFUL LCC MODEL

Rodney Stewart describes the most valuable automated cost-estimating tools as "the generic computer tools that can be used for any application . . ." Blanchard and Fabrycky say the model should be:

- comprehensive, include all relevant factors, and be reliable in terms of repeating results;
- representative of the "dynamics" of the system or product being evaluated and be sensitive to the relationships of key input parameters;
- flexible to the extent that the analyst can evaluate overall system requirements as well as the individual relationships of various system components. In the analysis process, one may wish to view the system as a whole, identify high-cost contributors, evaluate one or more specific components of the system independent of other elements, initiate changes at the component level, and present the results in the context of the overall system;
- designed to simplify timely implementation because, unless the analyst can use the model in a timely and efficient manner, it is of little value; and

- designed so it can be modified to incorporate additional capabilities. For example, it may be necessary to expand (or tailor) certain facets of the cost breakdown structure to gain additional visibility.

An LCC estimate should have sufficient accuracy to permit comparison of relative costs of design and acquisition alternatives under consideration by management. This statement means that an LCC model serves as a decision aid, and the model needs to capture enough (not necessarily all) of cost of ownership to facilitate well-informed decisions. The model developer identifies the main cost drivers of LCC and creates model algorithms to capture these costs.

A general-purpose model, which captures the costs of a systems major end item in terms of production, initial support items, operational use, and also the recurring costs on all of the ten support elements, can be expected to produce a good LCC estimate.

The cost analysis process includes the use of a detailed life-cycle cost model and aspects of risk, sensitivity, and data comparison analyses. Also, Research, Development, Test, and Evaluation (RDT&E) cost concerns as well as acquisition, operation, and support costs over the effective life of the system are included. Thus, a good life-cycle model covers the entire life of a system, from its initial research cost to those costs associated with yearly maintenance. Also, a good life cycle model covers spares, training costs, and other expenses that are incurred once the system is delivered.

The analyst formulates the problem statement to be analyzed, selects the appropriate model, and collects the appropriate amount of model input data. (Some model data may be left blank if it is not relevant to the problem statement.) The analyst also runs the model (including selected sensitivities) and draws certain conclusions from the model outputs. Later discussion will show that the CASA model fits all of these requirements. Professor Blanchard recently stated that the CASA model is the best LCC model available today.

16.4 DISCUSSION OF AVAILABLE COST MODELS

Research shows that a wide variety of LCC models have been developed. Some of these models are special purpose and others are general purpose. The government has regularly required that proposing contractors use the "government approved" models in estimating the cost of ownership of the proposed solution. This requirement ensures that all of the contractors and government LCC estimates are comparable, repeatable, and understandable. Many of these models are cataloged in the DoD Acquisition Logistics Guide distributed by the Logistics Support Activity (LOGSA), an agency of the Army Material Command that serves all of DoD in the area of logistics supportability assessment and related tools.

Interviews and surveys of many industry representatives have resulted in a finding that many government models were considered unnecessarily complex and "input data

hungry." Both industry and government program managers need a flexible model that can operate effectively with tailored levels of input detail, from simple to complex, depending on the decision being considered.

16.5 THE CASA MODEL

The CASA model is basically a management decision-aid tool based on LCC. CASA is a set of analysis tools formulated into one functioning unit. It collects, manipulates, and presents as much of the total cost of ownership as the user desires. It contains a number of programs and submodels that, along with LCC comparisons and summations, allow the user to generate program data files, perform life-cycle costing, perform sensitivity analysis, and perform LCC risk analysis. CASA offers a wide variety of preprogrammed output report formats designed to support the analysis process.

CASA covers the entire life of the system, from its initial research costs to those associated with yearly maintenance. It also covers spares, training costs, and other expenses once the system is delivered. Currently, RDT&E and production costs are "throughput" costs, i.e., they are not derived by the model; they are input and reported in some report outputs depending on their relevance to the analysis. The model calculates and projects the O&S costs over the 20 to 30 years of system operation. RDT&E and production cost-estimating modules are being considered in response to numerous user requests.

The CASA model employs some 82 algorithms with 190 variables. Only a small number of the inputs are mandatory. Most of the inputs are optional and are subject to tailoring to the needs of the analysis. CASA, therefore, is a relatively "compact" model designed to facilitate well-informed decisions while holding model input data gathering to a moderate level.

CASA works by taking the data entered, calculating the projected costs, and determining the probabilities of meeting, exceeding, or falling short of any LCC target value. CASA offers a variety of strategy options and allows for alteration of original parameters to observe the effects of such changes on strategy options.

At any number of program junctions, inputs may be saved and calculations may be made to that point for later evaluation. Furthermore, CASA will accept only correct input. The CASA checks all data as it is entered; incorrect data will cause the cursor to stop and/or alert the user.

CASA can be used for a wide range of analysis tasks, such as:

- LCC estimates,
- tradeoff analyses,
- repair-level analyses,
- production-rate and quantity analyses,

- warranty analyses,
- spares provisioning,
- resource projections (e.g. manpower and support equipment),
- risk and uncertainty analyses.
- cost-driver sensitivity analyses,
- reliability growth analyses,
- operational availability analyses with automated sensitivity analysis,
- spares optimization to achieve readiness requirements, and
- operation and support cost contribution by individual Line Replaceable Units (LRUs).

16.5.1 CASA Model Version 3.01

CASA version 3.01 has been distributed since 1995. This version expands the number of hardware items (repairable candidates) from 145 to 2,000. This feature, along with the LCC summation feature, virtually eliminates any limitation on the "size" of a system that can be analyzed. The model runs well on 386, 486, and Pentium PCs. It requires four to five megabytes of hard drive space, depending on the size of hardware data files. The program currently runs best in a DOS environment since it requires 580K of RAM to operate properly.

16.5.2 CASA Model Version 4.0

The newest version of CASA is in a Windows 95/NT format. This version includes many new features, including an embedded hypertext, paperless technical manual, and embedded computer-based training (CBT). The new model will retain all of the functionality of the previous versions, plus add the following features:

- ability to assign an operational availability target to be used in sparing to availability calculations;
- more flexibility in describing maintenance levels, i.e., regional maintenance;
- ad hoc rather than canned output reports and graphical output formats;
- digital technical manual imbedded into hyperlinked help files; and
- CBT and "wizard"-type examples.

Version 4.0 for Windows, like version 3.01 for DOS, expanded the number of hardware items (repairable candidates) from 145 to 2,000. This feature, along with the LCC summation feature, virtually eliminated any limitation on the "size" of a system that can be analyzed. Other new features are being considered in response to user requirements.

16.6 SOURCES OF THE CASA MODEL

The CASA model comes compressed on two program file disks; one disk contains the user's manual. There are a variety of sources of the model. Some sources distribute the model essentially free, but they offer limited user support. Other sources distribute the model for a modest fee to recover distribution and technical support costs. LOGSA is preparing to begin the distribution of CASA as a module of the logistics manager's tool set called Logistics Planning and Requirements Simplification (LOGPARS). Three points of contact for internal U.S. distribution of the model are:

- Defense Systems Management College, Logistics Management Department, (703) 805-2497

- US Army Materiel Command, Logistics Support Activity (LOGSA), (205) 955-988

- MAR-YAN Associates Inc., (301) 460-4050

17

CONTRACTING FOR LOGISTICS

Logistics in Time Saves a Return to the Prime.

17.1 OBJECTIVES

Contracting for support is the principal means to implement the government's logistics strategy. Contracting is done within the framework of contract laws and regulations and must be in consonance with the acquisition strategy approved by the milestone decision authority (see 17.2.3.1). Contracting is used to acquire many or all of the following logistics deliverables from commercial sources during system acquisition:

- logistics documentation, such as analyses, plans, designs, and reports;
- support materials, such as spare and repair parts, support equipment and software; and
- logistics services such as training, component repair, and "turn-key" maintenance and supply support of selected equipment (e.g., training simulators) or of the system.

Some of these deliverables may be procured under a separate logistics contract; others may be part of an overall program contract. In either case, the government's objectives are to satisfy its logistics support needs at a fair price within legal and regulatory boundaries. The contract will provide specific responsibilities for both parties. The general government contracting activities are listed below in chronological order:

- Acquisition Strategy
- Acquisition Planning
- Procurement Package
- Solicitation Process
- Proposal Evaluation
- Discussions/Negotiation and Contract Award
- Contract Monitoring

17.2 BACKGROUND

17.2.1 Acquisition Policy, Law, and Regulations

U.S. Government policy calls for heavy reliance on private commercial sources for supplies and services (Office of Management and Budget (OMB) Circular No. A-76, "Performance of Commercial Activities"). The Federal Acquisition Regulation (FAR) and other procurement directives set forth rules and procedures for implementing this policy. These documents reflect both the basic procurement law, the Armed Services Procurement Act, and revisions enacted during the annual authorization and appropriation process. The DoD implements and expands on the FAR in the Defense Federal Acquisition Regulation Supplement (DFARS) and Service supplements.

17.2.2 Contracting Authority, Responsibility, and Participation

Authority and responsibility to contract for authorized supplies and services are vested in the agency head and delegated to contracting officers. In turn, the contracting officer is responsible for ensuring that all requirements of the law, executive orders, regulations, and procedures have been met prior to exercising this authority. Although contracting officers are allowed wide latitude in exercising business judgment, they must ensure that contractors receive impartial and equitable treatment; and they must elicit and consider the advice of specialists in program management, engineering, logistics, and other fields as appropriate (FAR 1.602-2).

Specialists, such as Logistics Managers (LMs), must be involved in major contract events such as source selection. Major contracting activities such as developing the acquisition strategy for logistics are primarily the responsibility of the LM. The LM has some involvement in the entire contracting process from preparation of the procurement package to monitoring contractor performance.

17.2.3 The Contract Process

The primary contracting activities for the LM involvement include: developing the contracting strategy, planning the acquisition, recommending contract method and type, preparing the procurement package, evaluating proposals, and monitoring contract performance. These are discussed in FAR 7, 34, 35, and 37. Solicitation, negotiation, and award processes are the responsibility of the contracting officer, with assistance as required from specialists such as the LM (Figure 17-2). The LM should become familiar with his responsibilities for these contract events as they relate to contracting for support. Figures 17-1 and 17-2 display a generic chronology of contract events. These time frames are representative contract lead times under the Competition in Contracting Act of 1984.

17.2.3.1 <u>Acquisition Strategy</u>. The LM's acquisition strategy should permit prepriced competitive contracts. Other strategy considerations include appropriate implementation of warranties, breakout, and the consolidation of spare parts requirements (initial, follow-on, and replenishment). The logistics contract strategy must be compatible with the overall program acquisition strategy.

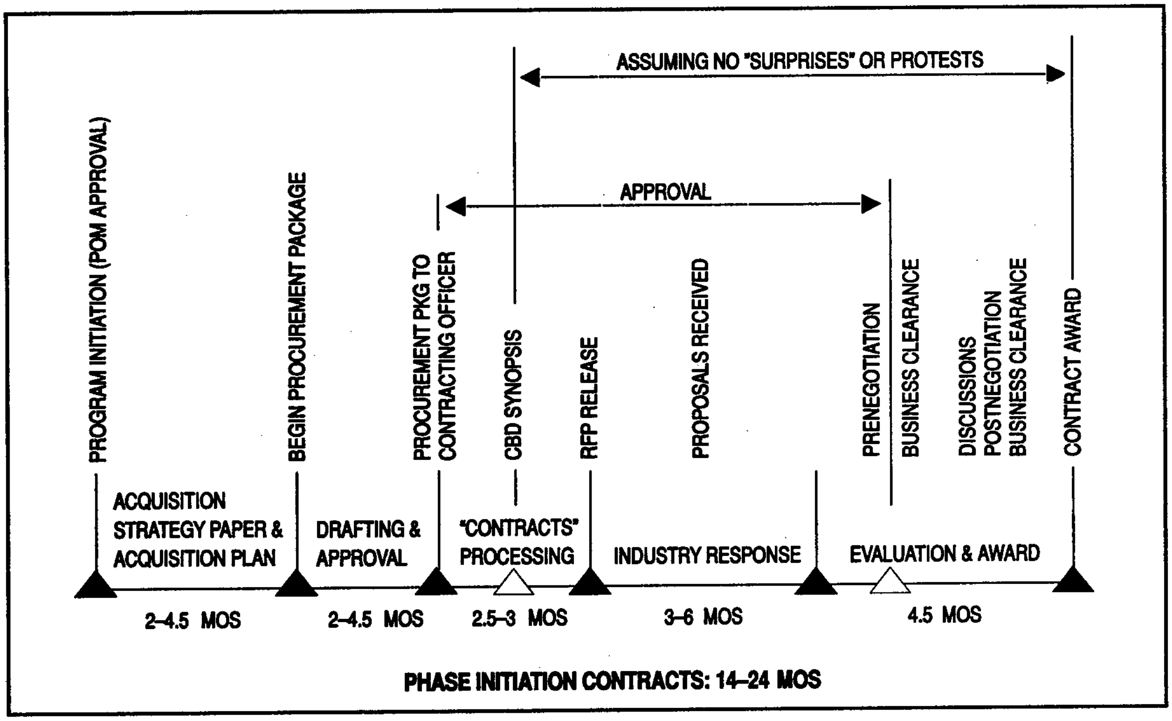

Figure 17-1: Procurement Action Cycles (Full and Open Competition)

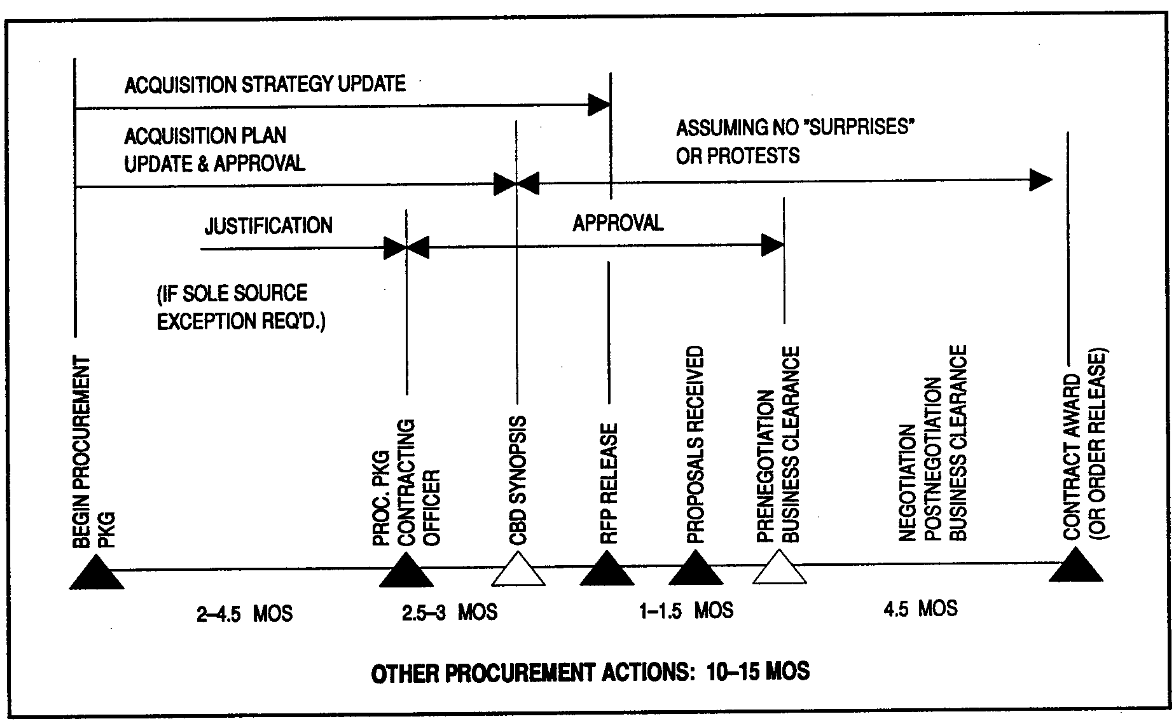

Figure 17-2: Support Contract Cycle (Sole Source)

17.2.3.2 Acquisition Planning. In planning the acquisition of logistics data, materials, or services, the LM should work with (or support) the government team. They are responsible for significant aspects of the acquisition, such as contracting, financial, and technical, which are needed to create an acquisition plan (FAR 7.105). A wide selection of contract types is available, and provides flexibility in acquiring the needed logistics resources. These contracts vary according to the degree and timing of responsibility (risk) assumed by the contractor for cost and performance and the amount and nature of profit incentive.

Contract types are grouped into two broad categories: fixed-price contracts and cost-reimbursement contracts. Specific contract types range from firm-fixed-price, where the contractor is fully responsible for performance, cost, and profit (or loss), to Cost-Plus-Fixed-Fee (CPFF), in which the contractor has minimal responsibilities for performance and cost but receives a negotiated fee (FAR 16). In Cost-Plus-Incentive-Fee (CPIF) contracts, the government still bears the major risk; however, the contractor's fee, i.e., profit, will vary based upon the achievement of those objectives that were incentivized in the contract.

17.2.3.3 The Procurement Package. The Procurement Package encompasses most of the information the contracting officer needs in order to prepare a solicitation as prescribed by "Part I – The Schedule of the Uniform Contract Format" (FAR 14.201-2). It provides technical and management information including the range and depth of data, materials, and services to be acquired. A timely and comprehensive statement is required for each acquisition involving equipment or processes needing future support materials, services, or data. MIL-HDBK-245B, "Preparation of the Statement of Work (SOW)," provides specific guidance on how to identify and present information on logistics deliverables in a format consistent with life-cycle phase requirements.

The LM should be concerned with each part of the Procurement Package because logistics requirements are normally spread throughout the document. Care should be taken in selecting and describing related deliverables. Plans, drawings, specifications, standards, and purchase descriptions should be selectively applied and tailored to the particular application in the SOW. Heavy reliance must be placed on commercial and/or performance specifications since many military standards, which provided guidance and requirements related to logistics, were canceled as a result of the Federal Acquisition Streamlining Act of 1995.

After reviewing the available standards bearing on a given topic, select the fewest number of standards that encompass the desired range and depth of logistics tasking in such areas as planning, supply, manpower, personnel, and training. Specific applications should be tailored to meet program needs by selecting or modifying standard Data Item Descriptions (DIDs). The procurement package should include:

- guidance to the contractor about the government's baseline of logistics – objectives, requirements, importance relative to other program objectives, concepts, assumptions, constraints, and priorities;

- specific logistics tasks to be performed by the contractor, such as logistics analyses, logistics alternatives evaluations, preparation of plans and concepts, training courses, spares and repair parts, technical data, etc.; and

- incentives aimed at achieving the desired balance between logistics and other performance capabilities.

The terms used must be understandable and consistent with standard contractual clauses. "Buzz words," terms with multiple meanings, conflicting or unclear terms, and symbols must be avoided.

17.2.3.4 Evaluating Proposals. The LM identifies and defines what logistics considerations should be addressed in the offeror's proposals and helps to determine the relative importance (weight) of evaluation factors such as understanding of the problem, technical approach, "other technical factors," experience, and cost. Other technical factors should provide measurable and meaningful criteria related to the specific logistics support requirements of the proposed system. These logistics considerations are also incorporated in the overall Source Selection Plan (SSP) which contains the evaluation factors and weights for each factor. These must be on record with the contracting officer and incorporated into the Request for Proposal (RFP) prior to RFP release. In preparing for evaluation working group meetings, the LM should independently evaluate all technical proposal items related to logistics in order to contribute meaningful leadership in the discussions leading to source selection.

17.2.3.5 Contract Monitoring. A comprehensive contract file is a useful management tool. This file should include all procurement and administrative contract modifications, which are referred to as "P mods" and "A mods." Data in the contract file directly relate actual performance to actual cost and, when automated, do so in a timely manner. During the performance period, this data should be used to rapidly identify, examine, and resolve logistics problems that arise.

17.2.4 Contracting Methods

The Competition in Contracting Act of 1984 requires agencies that are conducting procurements for goods and services to obtain "full and open competition" through the maximum use of "competitive procedures." This means that all responsible sources are encouraged to submit sealed bids or competitive proposals, depending on what is required by the solicitation.

There are two primary differences between the competitive procedures, which are known as sealed bids, and competitive proposals. The first difference relates to award factors. When sealed bids are used, the award will be based solely on price and other price-related factors. In contrast, competitive proposals permit consideration of other factors, such as technical merit, that go beyond cost in meeting the government's need.

The second difference involves the permissibility of negotiations to arrive at the business agreement. With sealed bids, discussions are not permitted, other than those needed for purposes of minor clarifications. Competitive proposals, however, do permit discussions and afford the offerors an opportunity to revise their offers subsequent to discussions. In context, "bargaining" refers to discussion, persuasion, and alteration of initial assumptions and positions. The give-and-take may apply to price, sched-

ule, technical requirements, and other terms of the proposed contracts. The use of "other than competitive procedures," (sole source negotiations) is only authorized when the circumstances of the acquisition meet the criteria of one of seven identified exceptions (FAR 6).

17.3 MANAGEMENT ISSUES

17.3.1 Data

In the past, a major data problem has been the incomplete identification of data requirements and the lack of emphasis on procedures that ensure legible, complete, and correct drawing practices. Contract requirements for a Technical Data Package (TDP) must be traceable to the government configuration management plan, which, in turn, must implement the acquisition strategy approved by the Milestone Decision Authority (MDA).

It is not easy to verify that the delivered product drawings and associated lists (e.g., specifications; software documentation; preservation, packaging, packing, and marking data; test requirements data; and quality assurance provisions) will satisfy all needs for competitive procurement. Personnel preparing the data and those reviewing it should be able to determine whether they could manufacture the documented component "without additional design engineering or recourse to the original design activity." One review approach is to award an independent verification contract to a manufacturing or production engineering firm that has relevant hands-on manufacturing experience. The following guidelines are offered for developing technical data packages:

- Determine the level of specificity required for procurement purposes.
- Ensure that the parts descriptions and drawings are available so other participants in the acquisition understand what is being bought.
- Establish prices and options for data delivery only after the design is stable enough to make it useful.
- Obtain technical data on a phased schedule to permit breakout of vendor components for future competitive acquisitions.
- Inspect and validate the completeness, accuracy, and adequacy of data promptly after its receipt.
- Consult with the contracting officer to ensure that the current regulations concerning data rights and data restrictions (FAR 27) are incorporated in the solicitation.
- Technical personnel should review proprietary or other restrictive markings on drawings and, when appropriate, request the contracting officer to obtain a written justification from the contractor for the restrictive marking.

17.3.2 Spares and Breakout

Decisions affecting spares must be made very early in the life cycle of a system. As the program evolves, the LM must issue provisioning technical documentation guidance via the contract. This guidance should include milestones and feedback reporting to ensure that program-unique materials are promptly ordered. The LM must also ensure that follow-on spare and repair parts are obtained in a cost-effective manner. Relying on the original prime contractor for follow-on support material entails risks in the areas of cost and availability of needed spare and repair parts – especially during the post-production support period (see Chapter 27). The LM should consider obtaining technical data, drawings, tooling, etc., to enable the Service to compete for follow-on logistics support. The cost of obtaining this capability must be weighed against the potential benefits of competition, particularly during an extended postproduction period. FAR, Part 7, requires the inclusion of detailed component breakout plans in the acquisition plan. In summary, to develop and deliver an effective spares package to future users, the LM should:

- ensure the timely and accurate assignment of procurement source codes (e.g., prime contractor, vendor, field manufacture, etc.) and challenge data rights and restrictive markings;

- require contractors to identify actual manufacturers;

- screen contractor-recommended parts lists to make full use of DoD and General Services Administration (GSA) supply systems;

- make sure parts already available in DoD and GSA supply systems are directly bought;

- order optimum quantities where significant savings can be obtained;

- base estimated unit prices on anticipated buy quantities rather than a single item; (Provisioning prices, i.e., prices established during the provisioning process, should not be used as the basis for determining the reasonableness of the price of future buys. Procurement history records should identify provisioning prices as such.)

- consider Spares Acquisition Integrated with Production (SAIP) where the government combines spare parts orders with planned production;

- encourage multi-year procurement of replenishment spares that are sensitive to quantity and front-end investment costs;

- ensure that all spare parts requirements (initial or replenishment) are combined to the maximum extent possible to achieve the savings of larger quantities; (Buying offices should alert users when frequent purchases of the same part are causing higher costs.)

- ensure realistic breakout and competition goals by considering savings potential and availability of procurement specialists to conduct competitions and breakout actions; and

- ensure that tradeoffs are made between inventory carrying costs and marketplace quantity discounts.

17.3.3 Contracts and Pricing

A Program Manager (PM) often regards logistics contract considerations, such as identifying logistics deliverables and creating the logistics input to the SOW, as long-term issues that are less important than the immediate problems. As a result, logistics concerns are often deferred for later resolution. A common example is the acquisition of data needed for future support. Understandably, the PM with a funding shortfall is more likely to cut the long-term logistics requirements from the contract than items with immediate impact.

An OMB review found that a large number of unpriced orders are backlogged at many DoD activities. The time required for audit, cost or price analysis, and negotiation of a contractor's proposal may relate to the number of cost elements to be negotiated. Solutions have included reducing the number of cost elements to be analyzed as well as avoiding the use of Basic Ordering Agreements (BOAs) and the ordering (provisioning) clause for the large amounts of data and spares that can be firm-fixed-priced at the time the order is placed. Another solution is the use of forward pricing arrangements. These provide for advance negotiation of direct and indirect cost factors that can then be used for a mutually agreed upon time. The re-negotiated logistics cost factors facilitate efficient pricing of a contractor's proposal by providing more time to analyze direct costs. These factors can be routinely used by less experienced buyers and are easily adapted to a computerized system. Increased emphasis on negotiating forward-pricing arrangements should result in a decrease in the number of outstanding unpriced orders. Goals should be set and monitored for the control of unpriced orders.

17.3.4 Government Furnished Property and Other Promises

The government's failure to provide promised Government Furnished Material (GFM) in a timely manner and in suitable condition may create a government liability for subsequent cost and schedule increases (FAR 52.245-2). Therefore, the LM should only identify GFM that the government can provide in a timely manner and in a condition suitable for use. If appropriate, the Contracting Office may allow the contractor to utilize MIL-STRIP procedures in obtaining the required GFM (FAR51).

17.3.5 Unrealistic Delivery or Performance Schedules

The government is capable of creating such pressure in negotiated contracts that a contractor may feel obligated to agree to unachievable terms. Subsequently, the contractor may seek and receive relief from unreasonable requirements. Therefore, LMs should avoid issuing requirements on an urgent basis or with unrealistic delivery or performance schedules since it generally restricts competition and increases costs.

17.3.6 Incentives

Incentive mechanisms in contracts are used to motivate contractors to exceed predetermined thresholds for performance, delivery, and reliability and maintainability (R&M), etc. Incentives provide this motivation by establishing a relationship between the amount of fee payable and the results achieved. When predetermined measurable incentives on delivery or technical performances are included, fee increases are provided for achievement that exceeds the targets; and fee reductions are made when targets are

not met. Incentive contracts are addressed in FAR 17.4 and in a joint DoD/NASA Incentive Contracting Guide. Logistics incentives should be designed to address one or more of the following conditions:

- Designs that tend to reduce logistics costs during the operational phase of the life cycle (increased use of standard components, reduced trouble-shooting time, etc.);

- Logistics system accelerated delivery (all elements) commensurate with accelerated program delivery; and/or

- R&M thresholds exceeded. (Incentives are established for significant goals that will yield increased combat effectiveness or decreased ownership costs.)

17.3.7 Warranties

This topic is covered in Chapter 19, Section 19.

17.4 RISK AVOIDANCE

The major risk area in logistics contracting, in terms of impact and the probability of its occurrence, is the failure to properly contract for data, materials, and services. Included are failures involving contractual promises by the government to furnish material and services and the imposition of unrealistic delivery or performance schedules. Impacts may include degraded support and readiness, cost growth, and loss of the taxpayers' good will and confidence. Contracting for support entails many areas of risk, which the PM must control. Permanent solutions to these problems are elusive unless management's attention is sustained at all levels. Without such attention, we will only repeat the mistakes of the past – a flurry of activity (amounting to overkill) dying out without producing meaningful or lasting improvements.

Toward the goal of improving logistics procurement practices, the Office of Federal Procurement Policy issued a report that offers more than 100 recommendations and suggestions aimed at avoiding well-known risk areas (Reference 2). Those most applicable to executive and working-level LMs are included in the guidance given in Section 17.3, "Management Issues." They may be used as a checklist, either to guide hands-on managerial efforts or to review the work of matrix personnel to ensure the price consciousness of their efforts.

17.5 CONTRACTING TOOLS

- LOGPARS (The Logistics Planning and Requirements System). This system was developed for use on a desktop PC. It is an expert system, which leads a LM through the thought process necessary to plan and execute a logistics program. The latest version (June 1997) includes important acquisition reform emphases. This tool is available on the internet at:

  http://www.logpars.army.mil/alc/logpars/logpars.htm

The system was developed by USAMC Logistics Support Activity, Redstone Arsenal, Alabama, and incorporates the required policy, lessons learned, and expert's experience to produce critical logistics program documentation. The systematic, user-friendly approach that LOG-PARS offers ensures all considerations are addressed, encourages compliance with existing policy, and eliminates potential for contracting redundant information

- Turbo Streamliner. This tool was developed and is maintained by the Navy Acquisition Reform Office and is available on the Internet at:

  http://www.acq-ref.navy.mil/turbo/

  It provides a checklist of Acquisition Reform topics, an RFP checklist, guidelines for reporting metrics, lessons learned, and guidelines for streamlining an RFP. It also provides a guide for assessing the effectiveness of the Acquisition Reform initiatives in the contracts awarded, based on RFPs evaluated during Phase I of the RFP Benchmarking effort.

17.6 SUMMARY

- Participation in the contracting process is part of the LM's job.
- Contract knowledge, initiative, and determination are essential in managing logistics programs.
- Logistics program success is a direct reflection of contract success.

17.7 REFERENCES

1. The Federal Acquisition Regulations (FAR).
2. Office of Federal Procurement Policy. "Review of the Spare Parts Procurement Practices of the Department of Defense," June 1984.
3. MIL-HDBK-245B, "Preparation of Statement of Work (SOW)."
4. Defense Federal Acquisition Regulations Supplement (DFARS).
5. DARCOM Pamphlet 700-21, *Integrated Logistics Support Contracting Guide.*
6. DoD/NASA *Incentive Contracting Guide,* October 1969, Army Field Manual 38-34, NAVMAT Pamphlet 4283, AF 70-1-5.

18

INFORMATION TECHNOLOGY[1]

JCALS Goal Statement: "Provide timely, authorized access to accurate, current data anywhere in the system regardless of where it is stored, how it is formatted, or how it is accessed."

Computer Sciences Corporation, in briefing to DSMC on 3 April 1997.

18.1 INTRODUCTION TO INFORMATION TECHNOLOGY DATA

18.1.1 Definitions

- Information Technology: "... any equipment or interconnected system or subsystem of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the executive agency ... includes computers, ancillary equipment, software, firmware and similar procedures, services (including support services), and related resources." (PL 104-106, Sec. 5002)

- Information Technology Architecture: "... an integrated framework for evolving or maintaining existing information technology and acquiring new information technology to achieve the agency's strategic goals and information resources management goals." (PL 104-106, Sec. 5125)

- Automated Information System (AIS): A combination of computer hardware and software, data, or telecommunications that performs functions such as collecting, processing, transmitting, and displaying information. Hardware and software computer resources are excluded if they are physically part of, dedicated to, or essential in real time to the mission performance of weapon systems. (DoD 5000.1, paragraph C.4.)

This Chapter gives emphasis to logistics information technology in the context of digital data, i.e., digitally developed (digitized) data that may be accessed or delivered, indexed, and maintained using automation techniques. Logistics digital information may take the form of technical data, drawings, schedules, or general reports.

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[1] Much of the material in this Chapter is drawn from the DSMC published report of the Military Research Fellows, DSMC, 1995-1996, *Navigating The Digital Environment: A Program Manager's Perspective,* by P. F. Cromar, A. G. Wiley, and R. L. Tremaine.

18.1.2 Application

Program Managers (PMs) and their systems engineering staffs (including logisticians) should consider how to apply and exploit the digital information environment. In this regard, Cromar, Wiley, and Tremaine (noted in footnote 1) offered the concept of an Acquisition Program's Digital Environment (APDE) to describe a cross-functional, integrated digital information infrastructure that supports a DoD acquisition program. The APDE links the entire acquisition program team, including not only the PM office and prime contractor personnel but also subcontractors, vendors, suppliers, support agencies, and end users. An APDE can take many forms, depending largely upon the extent to which an acquisition program is able to exploit digital information technology and integrate processes efficiently and effectively. If increased productivity and substantive cost savings through process improvement and reengineering are program objectives, evidence shows that such a digital environment is a key enabler and a necessary precondition for success.

18.1.3 Digital Fog

A "fog" can easily screen the PM's view of the digital information environment. The DoD and industry have been incorporating many digital initiatives for streamlining, promoting greater competition, and improving business practices for the last decade with a confusing number of digital directives, digital standards, and digital strategies. Integrating digital information environments is relatively recent and revolutionary. Notwithstanding, there is no single organization in the acquisition community responsible for developing and maintaining a roadmap that would help PMs navigate their respective digital domains. The researchers were told by one PM, "The lack of definitive guidance and a prescribed way to do it are the biggest blocks. We are having to feel our way through, and we may be going down a dead-end path." Not surprisingly, the employment of integrated digital environments within PM offices has been uneven. The creation of one might be constrained both by the PM's vision and the program budget, even though the PM may recognize "information technology must be viewed as an investment."

Even though available guidance on how to best exploit the digital environment to support their strategy has not yet materialized, a few program offices have taken advantage of the enabling and evolving digital resources. On the other hand, more and more industry partners are designing, manufacturing, testing, and supporting defense systems within digital environments, developing new systems digitally, and creating dynamic digital enterprises. Being at the center of their system enterprise, the government PM must understand an integrated digital environment before ever hoping to properly exploit its advantages.

Since 1988, the DoD has spent between 4 and 5 billion dollars fueling the many components of an Integrated Data Environment (IDE) in an attempt to accommodate the delivery of digital product data to the weapon system sustainment communities. Despite DoD's efforts, however, an IDE's benefits to the acquisition community are not always well known, well understood, or well communicated. In some cases, promises of significant overall cost reductions are not even believed. Most DoD training courses are

targeted toward logisticians, contracting officers, engineers, and data managers. They do not focus on PMs or on integrating processes. The basic construction of a robust IDE may not be inexpensive; this compounds the problem and raises the issue of who is responsible for payment. In light of shrinking defense budgets, PMs may be left with doing everything they can to simply sustain their program and continue to satisfy the user's needs. Since 1994, some major weapon programs have had to be realigned annually because of congressionally directed funding reductions. It is easy to understand why resources necessary for a robust digital environment may be sacrificed as PMs may not easily envision a return on investment during their watch. Clearly, the PM needs to know what is important and what works today: (1) before committing any program dollars for an APDE and (2) before the DoD can expect the PM to "buy-in" to the proposed merits of an APDE.

18.2 THE DIGITAL ENVIRONMENT

18.2.1 A Short History

The current DoD effort to move acquisition and logistics into the digital age began in late 1984 with the enactment of Public Law 98-525. An outgrowth of this law was an Institute for Defense Analysis (IDA) study released in June of 1985, which recommended a strategy and master plan for Computer Aided Logistics Support (CALS) for the management of technical data. This led to the establishment of the DoD CALS Office (now Continuous Acquisition Life-Cycle Support Office). The role of CALS grew in the late 80s and early 90s. During this period, Electronic Commerce/Electronic Data Interchange (EC/EDI) emerged to enable computer-to-computer exchange of business information. It provided a standardized means to integrate business functions, enable process improvements, and establish a basis for virtual enterprises. In 1994, EC/EDI responsibilities were moved from the CALS Office to an Electronic Commerce (EC) Office, established under the Deputy Under Secretary of Defense (Acquisition Reform) (DUSD(AR)). While supporting DoD-wide efforts to enable the exchange of a variety of business processes through EDI, the primary responsibility of the EC Office is to manage the implementation of EDI-based contracting. See Figure 18-1.

Recognizing the fact that the CALS effort started in the logistics community and organizationally remains under logistics makes it exceptionally hard to overcome the stereotype that CALS is a purely logistics program. Interviews by researchers Cromar, Wiley, and Tremaine (noted in footnote 1) showed that several senior DoD officials believe that the CALS current efforts concentrate primarily on logistics and sustainment activities. Similarly, EC Office efforts have been largely directed at the contracting community and small procurements, despite significant support to other EDI-related business processes. While both the CALS and EC/EDI offices are working to advance the acquisition community, the perception in the field is that they are separate, functionally based initiatives that do not specifically focus on or address the information and business needs of the PM.

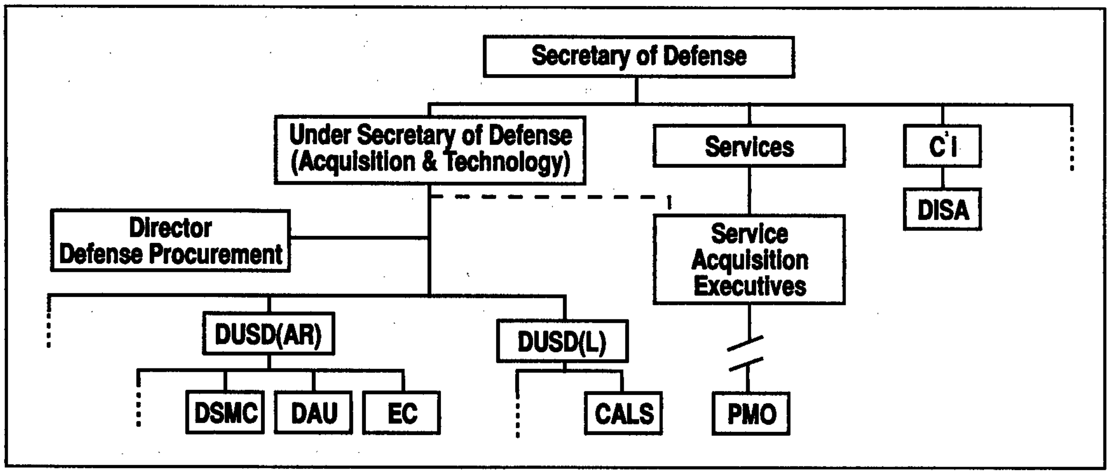

Figure 18-1: Major DoD Organizations Involved in the Digital Environment

18.2.2 Major Players

While DoD would like to present a "single face" to industry, the Services, and PM offices, there are a variety of organizations involved in different aspects of the digital environment. A digital environment that supports the acquisition community must interconnect with the Defense Information Infrastructure (DII), which, in turn, is an integral part of the National Information Infrastructure (NII). Agencies, apart from DoD, such as NASA, Department of Commerce, Department of Treasury, and the Department of Energy, are also affected. Business processes and standards clearly have global applications. This section identifies some of the major players involved in aspects of the digital environment and summarizes their functions, particularly as they impact the acquisition community. While many of these organizations will not directly affect PM offices, it is useful to understand their areas of focus and the roles they play.

18.2.2.1 DoD CALS Office. This office is under the Deputy Under Secretary of Defense (Logistics) (DUSD(L)) and is responsible for leading the DoD CALS effort. The CALS Office responsibilities include:

- Coordinating within OSD to define the IDE for business and technical information used for system acquisition and life-cycle support. (The IDE will be congruous with industry practices and the overarching DoD information infrastructure being developed by the Defense Information Systems Agency (DISA));

- coordinating the IDE framework within the DoD and ensuring integration of those requirements into DoD programs and processes; and

- participating with other government departments in an industry outreach program. (Through that program, the CALS Office promotes a commonly shared information framework, compatible information infrastructures, and similarity of acquisition practices.)

18.2.2.2 DoD Electronic Commerce (EC) Office. This office is responsible for facilitating the implementation of EC/EDI across all functional lines within DoD. It also developed the *Introduction to Department of Defense Electronic Commerce: A Handbook for Business*, Version 2, June 1996, which is a useful source of EC/EDI information. To date, the primary focus of the DoD EC Office has been to manage the implementation of EDI-based contracting systems within 244 DoD installations.

18.2.2.3 Director, Defense Procurement. As a Principle Deputy to the Under Secretary of Defense for Acquisition and Technology (USD(A&T)), the Office of the Director, Defense Procurement, develops, interprets, and publishes procurement policy for DoD. The Office of the Director also establishes requirements and guidelines that regulate the exploitation of digital environments and plays an integral role in DoD business process improvement initiatives. Defense Procurement sets policy for government rights to technical data and develops standardized procurement data definitions and a standard procurement process.

18.2.2.4 Defense Information Systems Agency (DISA). Under the auspices of the Assistant Secretary of Defense (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance), DISA is responsible for promulgation of standards and primary support of the DII. With respect to the development of a digital environment, DISA's role is to develop the computer systems architecture in close coordination with the Defense Information Systems Agency (DISA); the goal is to have it fully integrated with system migration planning and to be ultimately realized via the DII. The objective of the architecture is to completely describe the communications and computer system infrastructure necessary to support the IDE. Another objective is to develop the plan to efficiently migrate both the CALS flagship systems and the remainder of the DoD computer systems infrastructure that supports the weapon system life cycle to an IDE state. The computer systems architecture will include a systems specification that identifies the interfaces and performance standards necessary to meet the functional requirements of the weapon system support community.

The CALS Digital Standards Office at DISA is charged with overseeing CALS standards activities. DISA is also responsible for providing information pertaining to the testing and certification of Value Added Networks (VAN), which support the DoD EDI effort.

18.2.2.5 Other Organizations. Other organizations involved in different aspects of the digital environment include the: (Functions of these organizations are outlined in Section 18.7, reference 1, of this Chapter.)

- Defense Acquisition University/Defense Systems Management College,

- National Institute of Standards and Technology,
- Industry Steering Group, and
- Electronic Commerce Resource Center.

18.2.3 Definitions and Terms

This section will provide an overview of some of the major terms and initiatives that impact PM organizations entering the digital environment.

18.2.3.1 Continuous Acquisition and Life-Cycle Support (CALS). CALS is a DoD and industry strategy to accelerate the pace at which high quality information flows within and between DoD and its business partners. The CALS also provides an opportunity to reduce information management overhead costs. CALS is a core strategy to share integrated digital product data through a set of standards to achieve business efficiencies in business and operational mission areas.

The DoD CALS Office is committed to incorporating CALS into functional process improvements. As DoD attempts to apply the best technologies, processes, and standards for the development, management, exchange, and use of business and technical information among and within governmental and industrial enterprises, an IDE will be generated. DoD has developed a strategic plan to pursue its IDE vision.

18.2.3.2 Integrated Data Environment (IDE). The IDE is the business environment created by the application of existing national and international standards, practices, and technologies to automate the management and exchange of information. The vision of this DoD-wide IDE is a boundaryless environment where all data are accessible to appropriately cleared personnel in all defense enterprises. The IDE enables Integrated Product and Process Development (IPPD) while increasing the agility and decreasing the cycle times of the defense enterprise.

The goal of the IDE may be best summarized as an integrated digital environment linking all stakeholders in the life cycle of a weapons system and allowing cross functional sharing of data that is created once and used throughout the entire life cycle of the system.

18.2.3.3 CALS/IDE Initiatives. As part of the CALS strategy, the DoD is pursuing three infrastructure modernization programs with the goal of enabling the IDE. They are the Joint Computer-aided Acquisition and Logistics Support (JCALS), Joint Engineering Data Management Information Control System (JEDMICS) and Configuration Management Information System (CMIS). These three systems are being developed independently to work together in support of the DoD-wide IDE. The Army's Combat Mobility Systems (CMS) was the first program office to integrate these systems beginning in mid-1995.

18.2.3.4 Electronic Commerce (EC). The term EC is widely used by both the U.S. Government and industry. In industry the term EC is frequently used as the umbrella term to describe any digital exchange of information or data. Similarly, within DoD, EC is defined as the paperless exchange of business information using EDI, Electronic Mail (E-Mail), computer bulletin boards, facsimile, Electronic Funds Transfer (EFT), and other similar technologies.

18.2.3.5 Electronic Data Interchange (EDI). EDI is the computer-to-computer exchange of business information using a public standard. EDI is a central part of EC because it enables organizations to exchange business information electronically and much faster, cheaper, and more accurately than is possible using a paper-based system.

Who uses EDI? Currently about 50,000 U.S. private sector companies such as Federal Express, Eastman Kodak, American Airlines, Nike, Staples, Nations-Bank, JC Penney, and Prudential Insurance, use EDI. EDI is widely used in manufacturing, shipping, warehousing, utilities, pharmaceuticals, construction, petroleum, metals, food processing, banking, insurance, retailing, government, health care, and textiles, among other industries. According to a recent study, the number of companies using EDI is projected to quadruple within the next six years. The government did not invent EC/EDI; it is merely taking advantage of an established technology that has been widely used in the private sector for the last few decades. American National Standards Institute (ANSI) X12 U.S. commercial standards were developed to support EDI transactions for a wide variety of industry information applications. In the future ANSI X12 is expected to gradually align with an international set of EDI standards that are sponsored by the United Nations and known as Electronic Data Interchange for Administration, Commerce, and Transportation (EDIFACT).

18.2.3.6 Federal Acquisition Computer Network (FACNET). In 1994, Public Law 103-355, Federal Acquisition Streamlining Act (FASA), established the FACNET, requiring the government to evolve its acquisition process from one driven by paperwork to an expedited process based on EDI. The electronic system is intended to provide a "single face" to industry. FASA establishes parameters for FACNET users, both government and private. These functions are to be implemented by agencies within five years of enactment of the Act. The government-wide FACNET will be designed to:

- inform the public about Federal contracting opportunities,
- outline the details of government solicitations,
- permit electronic submission of bids and proposals,
- facilitate responses to questions about solicitations,
- enhance the quality of data available about the acquisition process, and

- be accessible to anyone with access to a personal computer and a modem.

Very simply, FASA raises the small purchase threshold to $100,000 and designates this as the simplified acquisition threshold. Procurement activities can use these new procedures when their activity is FACNET-certified. Although FACNET is currently in use by over 200 DoD organizations and installations, there are other potential options. With the advent of the World Wide Web (WWW) some government activities, most notably NASA and DLA, have chosen to employ what they consider to be more open solutions than those presented by the FACNET.

18.2.3.7 Contractor Integrated Technical Information Service (CITIS). CITIS is a contractor-developed and maintained service to provide electronic access and/or delivery of government-procured, contractually required information (i.e., Contract Data Requirements List (CDRL)). CITIS generally employs electronic networks for access and delivery of information and may include vendor and supplier data. It should be noted that CITIS is not the data itself or the database where it resides; CITIS is simply the service or mechanism that provides authorized users access to the data. CITIS can be the backbone of a Program Management Office (PMO) integrated data environment, providing significant benefits to the PMO. It provides a single entry point for authorized government access to contractor-generated CDRL data and supports the philosophy of creating data once and using it many times. CITIS establishes a set of core information functions to facilitate the concept of "shared data," and standardizes functional characteristics of the data to facilitate usage by a wide variety of different users.

18.2.3.8 Workflow Manager. A workflow manager is a software application designed to increase productivity. Using customized rules or knowledge-based processing, workflow managers enhance operations by automatically managing:

- single point of administration and maintenance;
- assignment of tasks (personal and group);
- automatic initiation of actions;
- coordination, timing, and sequencing of events;
- notification, suspenses, and e-mail-based reminders;
- work in progress reports (project and process status);
- continuous quality control (data integrity); and
- data rights and access.

A workflow manager can be a key functional component of an integrated digital environment, helping organizations achieve greater efficiency through near real time collaboration despite geographic and functional separation. By design, workflow managers go beyond e-mail by permitting greater flexibility through parallel processing, quicker access to the correct data by the right people at the appropriate time, and by providing a coordinated and integrated decision-making environment.

18.2.4 Acquisition Program's Digital Environment (APDE)

The researchers, Cromar, Wiley, and Tremaine (noted in footnote 1) developed the concept of an APDE. Defined as a cross-functional integrated digital environment linking the entire acquisition program team, the APDE is a realizable, program specific subset of the DoD-wide IDE vision. APDE focuses on an individual acquisition program with its development controlled by the PM. APDE supports program-specific requirements and enables process improvements, increases in efficiency, and reengineering efforts, which are achievable by both the PM office and government-industry acquisition partners.

An APDE can range from being very simple to very complex. At the low end, key people may share e-mail and limited information sets within the PMO and/or with the prime contractor, perhaps incorporating commercial software to facilitate data access. At the high end, an extensive digital infrastructure enables every active participant to have direct access to all pertinent data relating to one's function or process, regardless of the physical location of the database. These active participants include not only the PM office and prime contractor personnel but also sub-contractors, vendors, suppliers, support agencies, and end users. The elements may include topics noted in section 18.2.3 of this chapter. What is right for a particular PMO is a point somewhere along a continuum of increasing APDE complexity. As with the IDE, the use of standards to support data exchange and interoperability are essential to an APDE.

18.2.5 Digital Environment Summary

Moving into the information age and exploiting the potential of integrated digital environments is key to the future success of the acquisition community. As this movement necessitates crossing functional, organizational, and process boundaries, there are far reaching implications that impact DoD, the U.S. Government, industry, and even the international community. The defense acquisition community must at least be aware of these factors and attempt to take advantage of opportunities that they present. There are many organizations that play an active role in information technology and the digital environment, along with numerous ongoing and overlapping initiatives. In some cases, ongoing efforts are beyond the control of the PM. However, there is still much that can be done that will enable the PMO, and industry partners to capitalize on such items as the APDE initiative.

18.3 WHY USE A DIGITAL PROCESS?

There are two distinct, and somewhat overlapping, reasons for the PM to transition from a paper-intensive environment to a digital environment. The first is that DoD policy requires movement away from paper-based processes as quickly as possible. DoD Regulation 5000.2-R requires all new contracts (starting in FY97) to require online access to, or delivery of, their programmatic and technical data in digital form. A more compelling reason is that it simply makes good business sense. The importance of information technology to the logistics manager is addressed in section 18.6 of this chapter.

18.3.1 IPPDs and Reengineering

A key element in DoD's attempt to reengineer the acquisition process is the use of Integrated Product Teams (IPTs) and IPPD concepts. This is an area where defense acquisition programs can learn from industry. Many of the recent "success stories" in the media concerning improvement in competitiveness of American firms can be traced to the aggressive use of digital environments and the creation of an IPPD environment. One example is Boeing's decision to use Computer-Aided Three-dimensional Interactive Applications — CATIA software — for the development of the 777 aircraft. Boeing's management made the decision to change the culture of the company (IPPD) and invest $100 million in a computer-aided development capability. The bigger "investment" was in the total corporate commitment to this approach — there was no fallback approach in place.

As a result, there is no physical mock-up for an aircraft with 85,000 components and over four million parts. The goal is to achieve the same number of manufacturing hours as the 767 – for an aircraft with 57 percent greater empty weight – by reducing the number of design changes to at least one-half of that experienced on the 767. To date, Boeing is reporting a 93 percent reduction in the number of design changes. (To bring some balance to the above positive examples, the Journal of the DoD Reliability Analysis Center, Second Quarter 1997, reports a higher than expected rate of malfunctions on the 777 by one airline user; plus there are problems caused by electronic complexity and electromagnetic compatibility.)

A second example illustrates the point that computer-assisted integrated product development is not just for large corporations. Kohler's Engine Division, a producer of small 5 to 25 horsepower 4-cycle lawn mower engines, is a small player in a big field. Their business strategy is fairly straightforward — sell engines by offering superior performance and high reliability at a lower cost. Kohler has been using state-of-the-art CAD/CAM [computer-aided design/computer-aided manufacturing] tools to introduce new designs that are radically different from earlier versions, which is quite a departure from the evolutionary change approach traditionally practiced by this industry. At Kohler, manufacturing cycle times have been cut significantly. Physical prototypes are no longer necessary. Kohler offers a 2-year warranty — the longest in the industry.

In these examples, both companies implemented the commercial equivalent of an APDE to exploit an IPPD environment. This was made possible through the use of an APDE. The traditional use of prototypes to ensure form, fit, and producibility was obviated by the APDE's ability to enable a truly concurrent engineering and development process. This radical improvement in program performance is a clear example of why PMs should embrace the APDE.

18.3.2 The APDE and DoD

In DoD acquisition programs, well over half of the total life-cycle costs of weapon systems are fixed early in the program's development. The PM should focus on reducing total life-cycle costs early in the development process. The APDE directly enables this to occur by allowing the PM to create an IPPD environment to ensure that all stakeholders are involved and data and process requirements are identified up front. The PM can then plan for reducing long-term costs.

18.4 <u>THE DOD DIGITAL WORLD IN 1997</u>

Despite many positive efforts within DoD, the research report, *Navigating the Digital Environment: A Program Manager's Perspective*, concluded that:

> "There is no universal APDE standard or *truth* among the organizations examined. There are just too many implementation options available. As one expert in industry so fittingly stated, 'there is no silver bullet single solution. ... it requires a major investment which is difficult to find when the attention is on reducing overhead costs in a downsizing environment.' Because an APDE-like concept is relatively new and evolving, an understanding of the context of why and how organizations create them is essential. Our research further investigated barriers encountered in adopting an APDE. Not surprisingly, the researchers noticed a wide-range of reasons, both supporting and limiting APDE development."

18.4.1 Obstacles

Even though organizations are conducting business using digital technology, very few possess a coherent game plan that outlines the requirements and objectives for integrating digital environments. The knowledge level of particular software packages, like e-mail, word processing, and spreadsheets, and their respective benefits to individuals is high. Conversely, the level of understanding regarding how to integrate digital environments across functional areas and processes is low.

Cromar, Wiley, and Tremaine concluded that there are many misconceptions regarding the need for and general employment of an integrated digital environment. Only a limited number of the sites they visited seemed to appreciate what integrated digital environments offer, what constitutes an IDE, and what initiatives are available to help their organization

develop an IDE best suited to meet their needs. Most organizations that did recognize the need for an IDE were not aware of any resources available to help them construct one. Organizations feel they are on their own and tend to reinvent the wheel.

Other obstacles include the slow migration of certain enabling digital technologies within DoD, difficulty in selling the usefulness of information technology, decision makers believing in information technology cost savings, and related cultural barriers. Security concerns also exist in the area of proprietary data and classified data.

18.4.2 Standards and a Common Data Environment

The DoD is actively pursuing the use of commercial standards such as ANSI X12, standard generalized markup language (SGML), initial graphics exchange specification (IGES), and commercial products instead of government off-the-shelf (GOTS) packages. Quite a few organizations interviewed by the study group have installed commercial products as a solution for the management, exchange, manipulation, and storage of electronic data. This solution was used because some DoD-sponsored standard systems, like JCALS, JEDMICS, and CMIS, are still not sufficiently mature (in the opinion of some) and are considered to be less capable than commercial alternatives. According to a senior DoD official, some organizations also want to avoid the Ada (Department of Defense high order software language) paradox, according to a senior DoD official, where what had been originally designed to be a solution to interoperability has become a burden.

An example of the application of standards and a common digital environment is the Joint Strike Fighter (JSF) Program Office, formerly Joint Advanced Strike Technology (JAST) Program Office. With few exceptions, this office operates in a paperless environment. Early on, the JSF Program Office strangely pushed electronic procurement, even though there were few standards or experienced personnel to guide such efforts. They train, make decisions, plan upcoming phases, receive and evaluate deliverables, award contracts, conduct frequent management reviews, and review technical information – all electronically in a common data environment. In addition, they have online access to contractors' management information systems (MIS). The JSF Program also uses an Internet web site to distribute solicitations, broad agency announcements, and Request for Proposals (RFPs); respond to questions from potential offerors; inform prospective bidders of the latest information that might affect contract proposals; and answer questions related to their solicitations. The JSF Program has declared that business with them will take place digitally, and it subscribes to a common information systems environment.

18.4.3 Near-term Action

The CITIS is addressed in section 18.2.3.7 of this chapter. The careful design of a CITIS is probably the most important decision a PM can make in satisfying program data needs through an APDE. This is especially true in light of the requirements of DoD 5000.2-R, which states: "Support concepts of new and modified systems shall maximize the use of contractor provided, long-term, total life-cycle logistics support." In most cases, a

contractor's CITIS is robust enough to provide easy access to the data. Cromar, Wiley, and Tremaine revealed many variations in how DoD organizations establish and maintain connectivity among information environments. MIL-STD-974 defines the functional requirements for CITIS and permits a great deal of flexibility as evidenced by its four implementation strategies:

- Database repository resides with the prime contractor as a single physical integrated database.

- Database repository resides with the prime contractor as distributed multiple databases with a navigator (gateway processor).

- Database repository resides with the prime contractor; existing information systems are interfaced to extract CITIS data in a central repository.

- Database repository resides with the prime contractor and suppliers (many), with a navigator to pass requests/access to supplier databases.

Some PMOs tap directly into a prime contractor's CITIS, located either inside or outside the contractor's boundary, and extract the appropriate data on demand. Other PMOs avoid a CITIS and have the contractor deliver digital data to a remote server that is operated and maintained by the sponsor.

However, producing an efficient CITIS and justifying its usefulness is not an easy undertaking. A CITIS should have certain characteristics that everyone on the team understands, and it should be simple to use. CITISs must be reliable and straightforward; otherwise, the exchange of digital information, whether technical data, drawings, schedules, or general reports, can become a cumbersome and inefficient operation.

18.4.4 Digital World Summary

While there are many ongoing innovative digital initiatives throughout DoD, the acquisition community is not fully prepared to capitalize on the benefits or potential of integrated digital environments. Implementation of digital environments widely differs between the Services and PMOs. Lessons learned by industry in the exploitation of the information age and information technology are not well understood or appreciated within PMOs. The driving forces for organizations to adopt APDEs are reducing overall costs and increasing performance, not policy, mandates, or DoD direction.

18.5 PROGRAM MANAGER'S DIGITAL CONCERNS

The PM must have the vision or ability to understand the potential for a cross-functional, integrated digital environment. Interviews have shown that extensive technical knowledge or detailed, functional acquisition experience is clearly not a prerequisite for the success of an APDE. In fact, too much technical background or experience may result in decisions

being clouded by preconceived ideas. The PM must understand that information itself is an asset that needs to be managed carefully over the entire life cycle of the program. Information is more than simply a gathering of data used to describe assets and actions. Information has value, it has multiple uses and purposes, and it supports everything relating to the acquisition program. Properly managed, information can save time, increase efficiency, improve system quality and performance, and reduce cost. The APDE enables this effective management of information and information processes.

18.5.1 Gain Access to the Right Tools

In most PMOs, there exists a general lack of experience and knowledge with respect to the potential, requirements, capabilities, and limitations of an integrated digital environment. DoD acquisition personnel, and many industry managers for that matter, do not feel adequately prepared to develop an APDE infrastructure. The general sentiment from several study interviewees was that, "we don't even know enough to ask the right questions, let alone come up with the answers." It is important for the PMO to be able to access information and personnel that can help them negotiate an APDE development effort. The PM needs individuals with an understanding of APDE-related areas such as available technology; network support and network security; communications requirements and capabilities; data rights and access restrictions; CITIS; computer-aided design/computer-aided manufacturing (CAD/CAM); CALS; EC/EDI; national and international standards; and lessons learned from other PMO initiatives. In many cases the information and assets are not found within the PMO. Training programs, other DoD agencies, and PMOs, consultants, outside research, and contractors should be used extensively to support the APDE development process.

18.5.2 Policy Matters

18.5.2.1 <u>Programmatic Data</u>. DoD 5000.2-R states that, beginning in FY97, all new contracts shall require online access to, or delivery of, their programmatic and technical data in digital form, unless analysis shows that life-cycle time or life-cycle costs would be increased by doing so. Preference shall be given to online access to contractor-developed data through contractor information services rather than data delivery. No ongoing contract, including negotiated or priced options, shall be renegotiated solely to require the use of digital data, unless analysis shows that life-cycle costs would be reduced. This final item is being considered for revision.

18.5.2.2 <u>MAISs</u>. Further, DoD 5000.2-R describes operating procedures that are mandatory only for Major Defense Acquisition Programs (MDAPs), Major Automated Information System (MAIS) acquisition programs, and for other acquisition programs as specifically stated therein. DoDD 8000.1 provides complementary guidance for MAIS functional areas and describes management principles that are mandatory for all information management activities, including those related to acquisition of information systems, resources, services, and infrastructures.

An AIS acquisition program is a program that (1) is designated by the Assistant Secretary of Defense (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) as a MAIS or (2) is estimated to require program costs in any single year in excess of $30 million in fiscal year FY96 constant dollars, total program costs in excess of $120 million in FY96 constant dollars, or total life-cycle costs in excess of $360 million in FY96 constant dollars. MAIS acquisition programs do not include highly sensitive classified programs (as determined by the Secretary of Defense). For the purpose of determining whether an AIS is a MAIS, the following shall be aggregated and considered a single AIS:

(1) the separate AISs that constitute a multi-element program;
(2) the separate AISs that make up an evolutionary or incrementally developed program; or
(3) the separate AISs that make up a multi-component AIS program.

18.5.2.3 Technology Life Cycle. Numerous DoD senior leaders have made official reference to information technology (IT) having a life cycle of 15 to 18 months or less. The literature (government and commercial) is full of articles on new engineering developments. Subjects include a new computer from Sandia National Laboratories with broad military and commercial applications. It operates at nearly 2 trillion floating operations per second to nano-technology or molecular manufacturing allowing most products to be made lighter, stronger, smarter, cheaper and more precisely by rearranging atoms and molecules. However, as noted by Dr. D. L. Losman and Dr. K. B. Moss of the Industrial College of the Armed Forces in the May 1996, *Defense & Security Electronics*:

> "... demands of the commercial market have forced producers to change systems often to remain competitive. It is hard to imagine that the U.S. defense sector, given Congressional and presidential budgetary and oversight demands, would be able to accommodate the frequency of change that is the rule in the free-market commercial sector. Even if overall costs of electronics systems drop and thus allow more frequent changes to be financially possible (especially due to declines in the prices of hardware), Congressional budget review encourages adoption of defense systems that have longevity. Importantly, if the commercial world continually abandons older products as it moves toward newer designs and concepts, how will the military be able to provide logistical support and maintenance when the commercial products originally utilized are no longer being produced?"

For the DoD, this becomes a problem as commercial/non-developmental (C/NDI) purchases become the rule for IT; but, for both DoD and commercial markets, two other problems arise. First, when do you execute a purchase of a new or replacement IT knowing significant hardware/software improvements are likely to occur in the near term, i.e., how do you calculate your return on investment? For DoD, the relative slowness of the procurement process can mean that technology in the newly acquired product may be overtaken before the purchase is executed. Second, in a

logistics context, support plans for a new system may be delayed to the detriment of the new system because of delayed IT decisions. These decisions are delayed because of the desire to use the latest IT in the system or in support of the system. Thus, an insidious IT system/support decision loop can develop. Conversely, using currently available IT almost guarantees near immediate obsolescence. Discussion of these issues are conspicuously absent in the literature.

18.5.3 The PM Must Be Involved

The DoD strategy for an integrated data environment (IDE) is being developed by the DoD CALS office. Although CALS officially encompasses the entire life cycle of a program, the effort is run by the logistics community and has historically had a logistics focus. As a result, there is a tendency by materiel acquisition and program management to relegate IDE and CALS issues to their senior logistics personnel. This is a mistake. The PM must understand that the APDE, an acquisition program's functional equivalent to the IDE, potentially interconnects all program processes to become an indispensable tool for the PM.

18.6 LOGISTICS BENEFITS OF INFORMATION TECHNOLOGY

18.6.1 Joint Logistics

Information technology offers significant capabilities to Commanders-in-Chiefs (CINCs) as outlined in the Joint Staff's second draft of *Focused Logistics*, 30 April 1997. This draft states that "information fusion" is a primary tenant of *Focused Logistics* and is defined as "... the timely and accurate access and integration of logistics data across units and combat support agencies throughout the world providing reliable asset visibility and access to logistics resources in support of the warfighter." Accordingly, Global Combat Support Systems (GCSS) is a strategy to provide universal access to information and interoperability of that information across combat support and ultimately between combat support and command and control. A host of logistics information technology systems enablers are critical to GCSS. These initiatives are:

- automatic identification technology — ensures capturing source data from existing and future automated information systems such as bar codes, optical memory cards, radio frequency tags and movement tracking;

- joint total asset visibility — provides users with information on the location, movement, status, and identity of units, personnel and supplies;

- intransit visibility — tracks the identity, status, and location of DoD unit and non-unit cargo, passengers, and medical patients from origin to any destination; and

- joint decision support tools — aggregates, categorizes, and depicts information on force composition, environment, intensity and expected duration of operations.

18.6.2 Service Logistics

18.6.2.1 General Benefits. A primary objective of DoD information technology activity is to dramatically reduce product cycle times, to reduce DoD acquisition and support costs, and to improve readiness through reengineering acquisition and logistics processes. To attain these objects, the CALS' initiative provides the reengineering methodology, integrated information systems, and information standards that are necessary to re-invent acquisition and logistics processes across the Department. Furthermore, CALS' reliance on global standards versus defense-unique requirements directly facilitates commercial/military integration and defense conversion through streamlined processes that reflect world-class operations. As such, the CALS initiative directly supports ongoing DoD Acquisition Reform and logistics modernization efforts to reduce cycle time and life-cycle costs. Specific examples include:

- improving weapon system schedule and cost performance through reengineering and implementation of IDE;
- reducing the regulatory cost premium through policy reformation; and
- enhancing readiness through infrastructure modernization.

18.6.2.2 Specific Benefits. At this writing, the PM of Combat Mobility Systems (CMS) is a fully chartered element of the Program Executive Office, Armored Systems Modernization, responsible for the development and fielding of three weapon systems:

- M1 Breacher (Grizzly)
- Heavy Assault Bridge (Wolverine)
- Improved Recovery Vehicle (Hercules)

The first two systems are derivatives of the M1 Abrams and support engineer mission on the battlefield; the third system is a major improvement to the M88 Recovery Vehicle and supports ordnance missions. United Defense, Limited Partnership (UDLP), York, PA, serves as the prime contractor for Grizzly and Hercules, while General Dynamics Land Systems (GDLS), Sterling Heights, MI, is the prime contractor for the Wolverine.

The PM, CMS information technology concepts, planning, implementation, and approximately 25 of the program's logistics-oriented benefits from this initiative are documented in a five-page narrative on the "Web." The reader is urged to review this material at:

http://www.acq.osd.mil/cals/implcals.html

Broader examples of the logistics benefits of Service application of information technology are:

- Multi-user ECP Review System (MEARS). MICOM is automating the Engineering Change Proposal (ECP) review process with the development of MEARS. MEARS provides a tool to electronically review, comment, and vote on ECPs submitted by contractors. In the first year using MEARS, the Patriot Missile Project Office saved $250 thousand in paper alone.

- Automated Logistics Publishing System (ALPS). ALPS, a computer-generated publishing tool, is providing significant savings in the time and resources needed to support logistics publications. In addition to improved document quality, production cycle time has gone from 6 months to a few days; and the production cost per page has been reduced by 72 percent, saving more than $5.2 million over an 18-month period.

- Navy Interactive Electronic Technical Manuals (IETMs). The Navy has experienced financial savings on several systems employing IETMs relative to traditional documentation methods. In an effort to further reduce the cost of IETMs themselves, the Navy conducted a project to advance the technology necessary to allow for the automated conversion of legacy technical manuals (text, tables and graphics) to the IETM revisable database format (structured in accordance with MIL-D-87269). The conversion was to be accomplished with little or no human intervention. That goal was achieved in December 1996. As a result of the development of this automated conversion system, the cost of converting legacy technical manuals can be reduced from the current $130+ per page to a range of $40 per page or less. By transferring the technology to the commercial sector for development of commercial items, the Navy and DoD are relieved of the financial burden of maintaining, enhancing, and supporting a software system over a long period of time.

- Advanced Technical Information Support (ATIS). ATIS integrates digital engineering drawings, technical manuals, maintenance, and operational data through shipboard processing systems. Elimination of aperture cards reduced reproduction costs per ship from $54 thousand to $10.5 thousand per year and reduced the eight of shipboard storage media by close to two tons. Also, search and retrieval resources dropped from four experts to one novice per request; and the time needed to conduct a search has decreased from 30 hours to 10 minutes.

- ATIS for Naval Air Weapons System (ATIS/AIR). ATIS/AIR provides weapon system digital technical data at central technical publications libraries (CTPLs), staff offices, and maintenance workstations. It improves supply and maintenance process times; reduces the size, weight, and volume of shipboard CTPLs an average of 90 percent; and reduces librarian workloads by 30 percent for posting and distribution of technical data revisions.

18.7 REFERENCES

1. *Navigating The Digital Environment: A Program Manager's Perspective*, by P. F. Cromar, A. G. Wiley, and R. L. Tremaine, DSMC, December 1996.

2. *Focused Logistics, A Joint Logistic Roadmap*, 2nd Draft, (Information Fusion Chapter), The Joint Staff, 30 April 1997.

3. Public Law 104-106, Division E-Information Technology Management Reform.

4. *Introduction to Department of Defense Electronic Commerce: A Handbook for Business*, Version 2, DoD Electronic Commerce Office, June 1996.

5. Websites:

   - http://www.acq.osd.mil/cals/implem.html
   - http://wpafb1.wpafb.af.mil/train.html
   - http://immc.redstone.army.mil/CALS_Exchange/html/news.htm
   - http://catt.bus.okstate.edu/catt2/
   - http://navycals.dt.navy.mil/
   - http://www.navair.navy.mil/air30/air361/hp361.htm
   - http://wpaftb1.wpafb.af.mil/59b/home.html

PART IV

SPECIAL TOPICS

19

CONTRACTOR LOGISTICS SUPPORT AND WARRANTIES

You can't fly an aircraft without two tails,
one of which stretches back to the prime.
Hangar philosophy

19.1 DEFINITIONS

- Contractor Logistics Support (CLS) is the performance of maintenance and/or material management functions for a DoD system by a commercial activity. It is DoD policy to maximize the use of long-term CLS in support concepts for new or modified systems. In addition to the three levels of maintenance (organizational, intermediate, and depot), support may include provisioning, management, distribution, or repair of system spares. Planning for CLS should be documented in the support plan for the item being acquired. Further, CLS can effectively be utilized to support depot field teams, low-surge workloads, small workloads, commercial off-the-shelf items, and short life cycle or rapidly obsolete items. Additionally, CLS should be considered for high-surge workloads that either involve unique processes for capabilities that cannot be established organically at reasonable cost or for any support factors that clearly demonstrate a potential for lower costs and/or increased readiness.

- Product Assurance Plan implements a product assurance program including Reliability, Availability, and Maintainability (RAM), quality hardware and software, and system assessment to ensure user satisfaction, mission and operational effectiveness, and performance to specified requirements.

- Warranty is a promise or affirmation given by a contractor to the government regarding the nature, usefulness, or condition of the supplies or performance of services furnished under a contract. Refer to Title 10 U.S.C. §2403 for the mandatory use of warranties in systems acquisition.

19.2 CONTRACTOR LOGISTICS SUPPORT (CLS)

19.2.1 The Benefits

The benefits of proper implementation of CLS follow.

- a reduction in the annual appropriated spares requirements, assuming that the CLS contract results in a reduction in pipeline spares;

- a reduction in the DoD infrastructure (e.g., manpower, spares, facilities, etc.) as the contractor assumes management and maintenance responsibilities;

- a long-term increase in component reliability at limited cost to the government, assuming the CLS contract incentives provide an appropriate profit motive for realized reliability growth; and

- assistance with the maintenance of the defense industrial base in times of tight defense budgets.

19.2.2 The Challenges

The implementation of a CLS contract is not without its challenges and constraints. The Logistics Manager (LM) should be aware of these challenges and make appropriate efforts to develop the support program around them. At least two of the challenges are derived from legislation and regulation:

- Legislation mandates that 60 percent of depot-level maintenance will be performed organically.

- The Federal Acquisition Regulations (FAR) and the budget processes restrict contract length. Currently, DoD is restricted to a contract length of one year, with four successive one-year options; the options can be exercised at the pleasure of the government. With the service life of many DoD systems reaching out to 30 years or more, this limitation adds an element of risk and uncertainty to the CLS approach.

Other considerations include providing for wartime surge demands, sufficient organic workload to maintain organic expertise, and appropriate levels of competition in contract awards. The LM must also cope with the effect of the contractor's learning curve when competition leads to a change of contractors.

19.2.3 Automated Tools

There are only a few automated tools to assist in the development or management of a CLS contract, and they are limited in availability and function. Currently the most popular tool in classroom use at DSMC is COMPASS, which is being revised as a Windows 95 compatible program. The Navy has a software package in use today, CAMMS, which displays status of assets undergoing repair at contractor facilities. CAMMS allows the item manager to maintain 100 percent visibility of commercial assets, as if they were being worked on at an organic site. Additionally, the Internet provides information regarding CLS.

19.2.4 Points of Contact

- ASC/XLXS (DSN 785-2553)
- HQ AFMC/D RMP (DSN 787-7280)
- OCALC/LK (DSN 336-5772)
- OOALC/LIR (DSN 777-4614)

19.1.6 References

- DoD 5000.2-R
- U.S. Air Force Instruction 21-102
- U.S. Army Regulation 700-12, Chapter 5
- *DoD Acquisition Deskbook*

19.3 WARRANTIES

19.3.1 Description

The principal purposes of a warranty in a government contract are to delineate contractor and government rights and obligations for defective items and services, and to foster quality performance. Generally, a warranty should provide the following:

- a contractual right for the correction of defects notwithstanding any other requirement of the contract pertaining to acceptance of the supplies or services by the government; and
- a stated period of time or use or the occurrence of a specified event after government acceptance when a contractual right for the correction of defects can be asserted.

The benefits to be derived from a warranty must be commensurate with the cost of the warranty to the government. In 1985, Congress established a requirement for express warranties in production contracts for systems that exceed a unit cost of $100,000 or $10 million total cost. The warranties address conformity to the design and manufacturing requirements, freedom from defects in materials and workmanship at the time of delivery, and conformity to "essential performance requirements" (such as operation capabilities and reliability). In effect, the warranty is an obligation on the part of the contractor to repair or replace equipment found defective or to compensate the government for repair performed by the government during the course of the warranty period.

The FAR and the Defense Federal Acquisition Regulations Supplement (DFARS) also provide policies and procedures for tailoring the required warranties to the circumstances of a particular procurement and for obtaining waivers when needed. For supplies and services that do not meet the definition of a system, such as spares and data, warranties may be used, if they meet or exceed the foregoing thresholds and are advantageous to the government. A warranty of technical data (extended liability) should normally be included in the solicitation and evaluated on its merits during source selection.

19.3.2 Guidelines

Warranties can offer unique opportunities to implement innovative cost and supportability solutions. Use of warranties should be included in risk management studies. Applications for logistics-oriented warranty considerations include these factors:

- Nondevelopmental Items (NDIs) and Commercial Items (CIs),
- increasing reliability in fielded systems,
- system complexity,
- projected system/equipment usage rates,
- reliability testing and results,
- cost benefit analyses,
- commercial repair, and
- CLS.

Warranties must be bilateral agreements between government and industry. For warranties to be successful, they must offer benefits to all parties involved.

The type of contract used to acquire spare parts or repair services limits the extent to which warranties can be used successfully. Warranties are normally applied to the fixed-price type of contracts. They are less appropriate for Fixed Price Incentive fee (FPIF) target contracts. The cost-sharing mechanism of FPIF contracts normally means that the government will incur a substantial portion of the costs associated with warranty repairs and correction of deficiencies. They should not be used in cost-reimbursable contracts since the government would pay for most, if not all, of the costs associated with the warranty. In such cases, incentive or award fee provisions should be used to provide profit incentives to obtain desired contractor performance.

Appendix E of the *DoD Flexible Sustainment Guide* (see Section 19.3.3 below) provides helpful guidance for the selection of appropriate types of warranties. It suggests warranty

types that should be considered dependent upon whether contracting for spare parts or repair services. Reliability Based Logistics (RBL) is a subject discussed in Chapter 26, Section 26.4, of this Guide. Certain criteria associated with RBL impact the type of warranty that should be used.

In designing or selecting the contract warranty clause, the LM should consider the following guidelines:

- Maximize the government's ability to use the warranty. Be sure to consider transportation and storage factors.

- Provide a mechanism for administering the warranty that imposes limited or no special reporting requirements on the user personnel, particularly at the organizational level.

- Avoid warranty clauses and procedures that will, when exercised, have an adverse impact on readiness. (An example would be excessive downtime while waiting for contractor replacement or repair of the warranted components.)

19.3.3 Reference and Point of Contact

DoD Flexible Sustainment Guide of 23 January 1997. Mr. Jerry Beck of NAVAIR is the point of contact; his telephone number is (301) 342-3838, ext. 188.

20

SOFTWARE LOGISTICS

"Planning for supportability up front is a major determinant of software development success. Software, not developed with maintenance in mind, can end up so poorly designed and documented that total re-development is actually cheaper than maintaining the original code."[1]

20.1 DoD 5000.2-R POLICY

Software shall be managed and engineered using best processes and practices that are known to reduce cost, schedule, and technical risks. It is DoD policy to design and develop software systems based on systems engineering principles, including the following:

- developing software system architectures that support open system concepts, exploit commercial computer systems products, and provide for incremental improvements based on modular, reusable, extensible software;
- identifying and exploiting software reuse opportunities, government and commercial, before beginning new software development;
- considering Ada programming language (no longer an across-the-board requirement) to develop code for the life-cycle maintenance and support,[2] for which the government is responsible.
- using DoD standard data; (Additional guidance is contained in DoDD 8320.1.)
- selecting contractors with the domain experience in developing comparable software systems, a successful past performance record, and a demonstrable mature software development capability and process; and
- using software metrics to effect the necessary discipline of the software development process and assess the maturity of the software product.

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[1] *Guidelines for Successful Acquisition and Management of Software-Intensive Systems*, Vol. 1, Part 2, Version 2, June 1996.

[2] In accordance with DoD policies, based on recommendations from a National Academy of Sciences October 1996 study, programming language selections should be made in the context of the system and software engineering factors that influence overall life-cycle costs, risks, and potential for interoperability.

20.2 DEFINITIONS

- Software is a set of coded computer instructions and associated procedural data that direct computer hardware to perform computations or control functions.

- Firmware is a marriage of software and hardware in which read-only type of software is installed in a hardware item. As a result, the software element is difficult to change or update once it is installed.

- Computer Software Configuration Item (CSCI) or Software Item (SI) is a functionally or logically oriented set of software that is controlled by configuration management in the same manner as an item of hardware.

- Computer Software Documentation is the technical documentation that describes the capabilities and limitations of a CSCI or SI; it also provides operation or maintenance instructions for the software.

- Hardware Configuration Item (HWCI) is a functionally or logically oriented distinct set of firmware that is controlled in the same manner as a CSCI or SI.

20.3 BACKGROUND

Software is present throughout a typical weapons system, in both mission-critical applications programs and the related support structure. Figure 20-1 graphically portrays the many software applications that might be present in such a system. Clearly, today's acquisition personnel require an understanding of hardware, software, and firmware within the context of the acquisition process.

The bulk of the DoD's annual expenditures for software is for Postdeployment Software Support (PDSS). (See Figure 20-2.) Since the 1960's, software costs have risen at a proportionately greater rate than other system costs. Over the past several decades, the flexibility of software has generated a progressive trend of replacing hardware with software wherever technologically feasible. Figure 20-3 shows the growth in the size of software from the introduction of the F-4 aircraft in the 1960 timeframe to the present. In addition to size, complexity is on the rise; this trend affects every phase of the software life cycle from design to testing and support. The costs of software will continue to rise dramatically. Program offices will need to take action to mitigate the effects of increasing reliance of software. The program office will need greater understanding of the risks associated with the software development process and how such risks can be mitigated. They must also develop a willingness to address long-term software supportability issues. In fact, these trends indicate that the future capability of our major software-intensive systems is inexorably dependent on the Services' ability to cost-effectively maintain them.

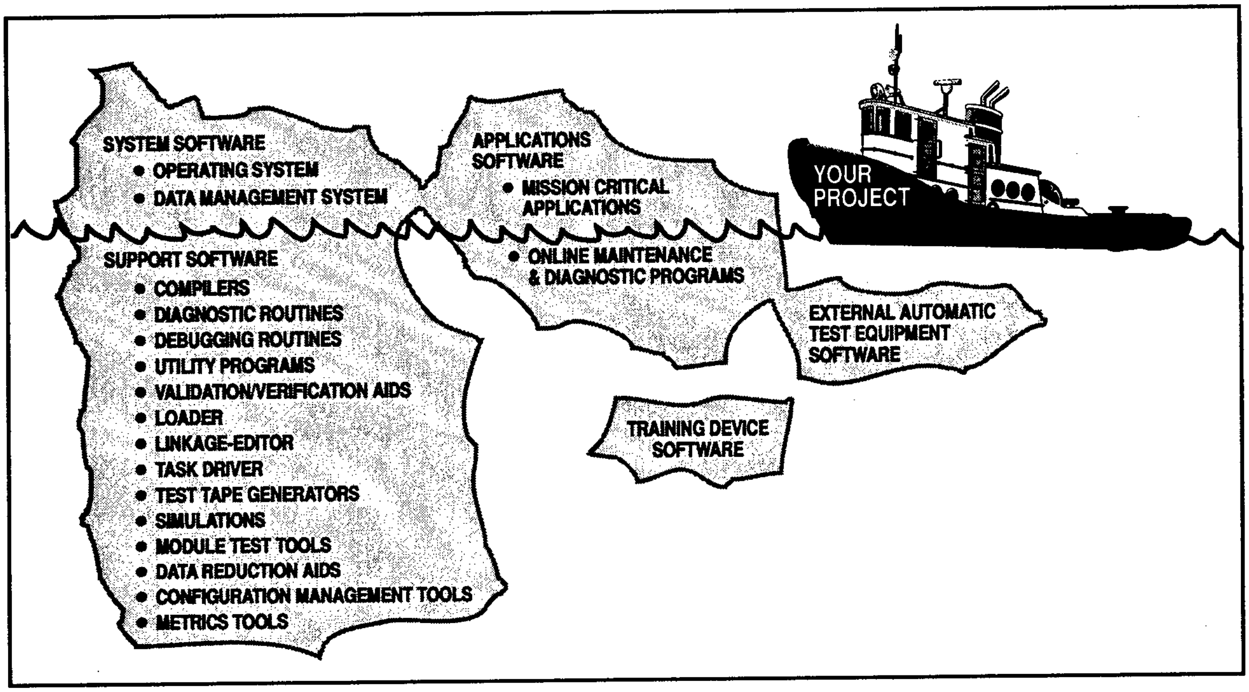

Figure 20-1: Types of Software

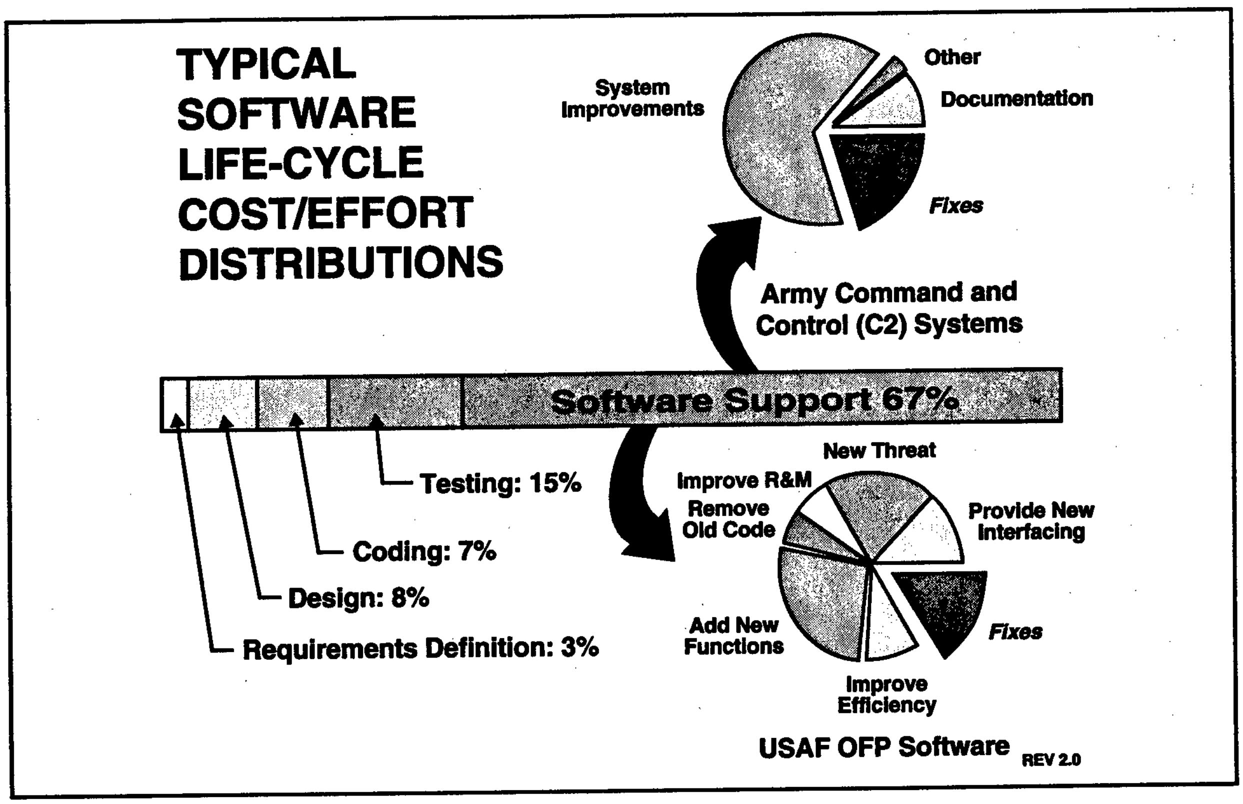

Figure 20-2: Software Cost/Effort Distribution

WEAPON SYSTEM	LINES OF CODE
F-4	2,000
F-16D	236,000
C-17	2,000,000
B1-B	1,200,000
F-22	7,000,000

Figure 20-3: Weapon System Software Complexity

20.4 LOGISTICS CONSIDERATIONS[3]

Many of the basic logistics concepts apply to software planning. Design criteria for supportability should be established for software just as they are for hardware. Reliability and maintainability should be addressed in detail. MIL-STD 882B addresses the safety aspects of software because the hazards associated with software malfunctions must be thoroughly examined and eliminated where necessary. Each of the ten elements of logistics support should be considered for the impact of software, just as for hardware. A listing of the logistics elements, together with the software issues associated with each, is contained in Chapter 7 of this Guide. Although logistics concepts for software are similar to those for hardware, there are some key differences:

- Software does not fail in the classical sense. Hardware typically degrades over time as components wear out. A software problem is due to an error that has existed in the program since its creation. (Refer to Figure 20-4.) When a problem caused by a component failure is found in hardware, the "solution" entails bringing the hardware item back to its original configuration (the product baseline). In the case of software, when a problem is found and corrected, a new configuration is created. Hence software "maintenance" inherently involves continuous changes to the product baseline.

- Software does not wear out like hardware, so the term "software maintenance," although widely used by commercial industry, is technically a misnomer. The appropriate name for this effort is software support. It is for this reason that PDSS is often called the redevelopment phase. As defined by the Institute of Electrical and Electronics Engineers (IEEE), software maintenance (i.e., support) is the "modification of a software product after delivery to correct faults, to improve performance, or other attributes, or to adapt the product to a changed environment."

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[3] Section 20.4 and its subsections contain information extracted from the "Aerospace Information Report – AIR5121" of the Society of Automotive Engineers' G-11 Reliability, Maintainability, Supportability, and Logistics (RMSL) Software Committee, September 1966. Information is also extracted from the "Guidelines for Successful Acquisition and Management of Software-Intensive Systems," Vol. 1, Part 2, Version 2.0 of June 1996, available from the Software Technology Support Center, Ogden ALC/TISE, Hill AFB, UT 84056-5205.

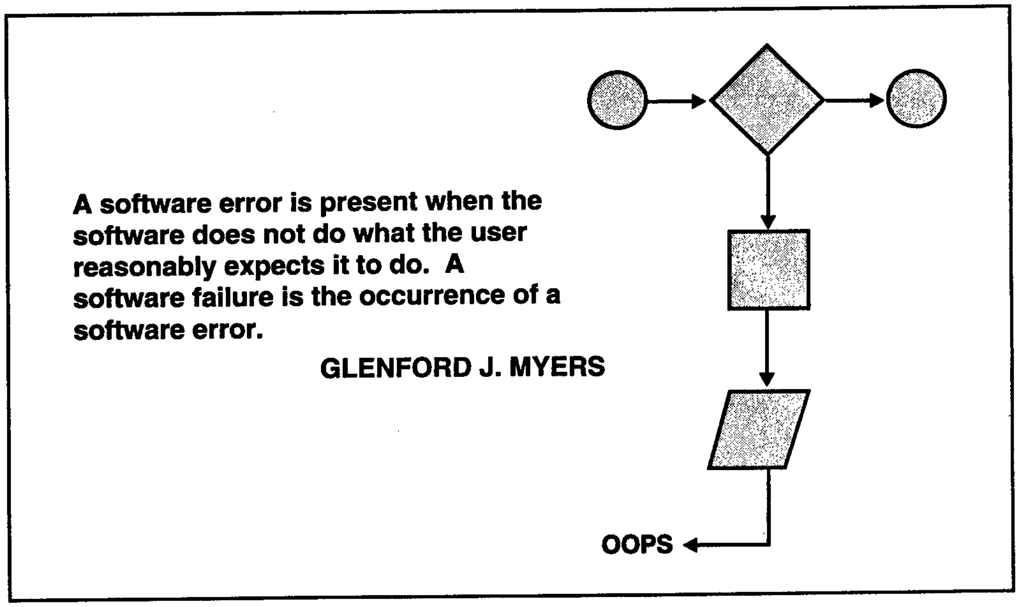

Figure 20-4: Definition of a Software Error

- The computer programmers involved in software support require programming skills approximating those of the original software developers. The programming effort entailed in introducing software changes, whether in the form of corrective action or performance enhancement, is frequently just as challenging as that entailed in creating an initial CSCI. A major difference between the software developer and the software maintainer is that the former has no product knowledge because the product does not yet exist; the software maintainer, on the other hand, must have complete product knowledge to do his job well. In this sense, software support may be at a slightly higher skill-level requirement than software development.

20.4.1 Key Elements of a Software Support Concept

At the simplest implementation level, a software support concept identifies a software engineering capability with the personnel resources and skills, physical facilities, and support systems to undertake ongoing development and change implementation. A customer/supplier procedural interface, through which queries, change requests, and updated products pass, must also be defined. The resources committed to the support function represent a significant part of the software life-cycle costs in terms of both capital investments and operation expenses. Judging the optimum scale of this investment involves trading off the costs of support against the operational benefits to be derived. The supportability analyses must provide guidance for a support concept that balances reliability, maintainability, and operational effectiveness with acceptable cost parameters.

20.4.2 Software Support Tasks and Initiator Events

For any computer-based system there will be a number of different situations that could initiate the need for software support task activities. It is important to examine such support initiators and the consequent support requirements at the same time that equipment design alternatives are being considered. The events or situations that may initiate software support task activities

should be grouped according to common operation, modification, and logistics management support impact. A set of top-level software support initiator groups should be defined against which the support requirements of the subject software item may be determined. These initiator groups should be adapted as necessary to the individual nature of specific systems and the impact of the software on system use and mission capability. Some of the software support tasks and possible initiator events are illustrated in Table 20A.

TABLE 20A
SOFTWARE SUPPORT TASKS AND INITIATOR EVENTS

Support Area	Support Task	Support Task Initiator
Operational	Installation	Release Distribution
	Data Load and /or Unload	Mission Preparation/Completion
	Backup	Preventive Maintenance Schedule
	Failure Reporting	System Failure
	Recovery	System Failure
	Training	Personnel, System, Software, Procedures, Update
Modification	Corrective Maintenance	Software Failure
	Perfective Maintenance	Change in User Functional or Performance Requirements
	Adaptive Maintenance	Change in Hardware or Commercial Software
	Configuration Management	Completion of New SW Version
Logistics Management	Release Replication	Field Loss of System & Backup
	Release Distribution	Release of New SW Version
	Installation of Commercial Software	Release Distribution
	Help Desk Management	Field Problem Query

Defining initiator groups, conducting supportability analyses, and identifying an appropriate support concept may be carried out iteratively during the development phase (and even the support phase) of a program/project. Each iteration should build on the previous analysis and use the results to modify or validate the evolving software support concept. At the earliest development stage, an analysis of support initiators should be undertaken as part of the requirements identification process. The aim should be to ensure that the software design approach takes account of what postdelivery changes may be anticipated. The support capability must be responsive and efficient in satisfying user needs and minimizing the life-cycle cost of support resources.

Design characteristics that affect software supportability include:

- design complexity (including related attributes of software size, structure, and interrelationships),
- stability and flexibility of the design itself and adequacy of documentation,
- completeness of the software development effort, and
- the extent and implementation of configuration management practices for both operational and support software.

Other factors within the development environment that impact software supportability include:

- availability of qualified software personnel,
- system structure understandability,
- ease of system handling,
- use of standardized programming languages,
- documentation structure standardization,
- test case availability,
- built-in debugging mechanisms,
- availability of original development documentation to the maintenance organization, and
- availability of appropriate computer hardware to conduct maintenance activities.

Software support includes support of government-developed software, contractor-developed software, and commercial software. (Chapter 21 is devoted to the subject of commercial and nondevelopmental items.) The following are issues to consider when supporting commercial software:

- The acquisition agent must acquire appropriate documentation and data rights, licensing, and subscription services (such as options to purchase or escrow proprietary information), which allows the government to support the software if contracted support becomes unfeasible.
- The Software Support Activity (SAA) must maintain appropriate licensing and subscription services (vendor field change orders and software releases) throughout the life of the system.
- Commercial software resources must not be altered to preclude contractor logistics support or void licensing or subscription services.

- The supporting command must provide logistics support and provide a contract for subscription services required to update and maintain commercial software assets. It must also evaluate operational and logistics impacts of change due to subscription-related hardware and software upgrades.

- The operational command must provide a technical review of proposed changes during upgrades and changes to commercial software assets. It is responsible for evaluating the effectiveness and mission impact of changes due to subscription-related software upgrades.

20.4.3 Life-Cycle Support Strategies

Life-cycle support strategies ensure that the contractor, when developing the software, addresses information and documentation management, quality, and verification procedures. Typical life-cycle support strategies available for source selection include the following:

- Sole source (original contractor). The original contractor is awarded the software support contract. The processes, products, and support system are already in place at the contractor's facility and typically are the same as those used during the development.

- Competitive (support equipment provided). A competitive contract is awarded; and the processes, products, and support systems are either transferred from the original contractor facility to the competing contractor or the items are duplicated. The original contractor can also be a competitor.

- Organic/contractor mix. The government and the contractor share responsibility for software support. Each agent is assigned a percentage of the software to be supported. Typically, the government and contractor are collocated. The processes, products, and support systems are relocated to a government support center; or the items are duplicated. Either the original contractor or a competitive contractor will share the manning of the effort with the government.

- Organic. The government assumes responsibility for software CSCIs. The processes, products, and support systems are relocated to a government support center or duplicated. Government, i.e., organic, personnel execute the support processes.

20.4.4 Computer Resources Documentation

Hardware and software support concepts should include plans for upgrades or technology insertion over a nominal 10-year life cycle following fully operational capability.

DoD 5000.2-R does not require a specific format for documenting software development and logistics support effort. However, the PM should oversee the creation of such a document in the

early stages of system development. It should clearly identify the computer resources of the system and partition the system into HWCIs and CSCIs. Table 20B provides a guideline for a proposed system's computer resources support documentation. Although there is no requirement for a stand-alone program document, it is still a valuable management tool and is recommended as such.

TABLE 20B
COMPUTER RESOURCES SUPPORT GUIDELINES
(Optional Document – Notional Outline)

Introduction

Referenced documents

Support information

Support environment(s)

Support software required and uses of each

Support hardware required and uses of each and relationship to support software

Facilities required, including description of purpose, recommended location, predicted utilization rates, and special requirements

Personnel requirements, including skills, skill level, training, experience, and security clearance requirements.

Other required resources

Operations, including general usage instructions such as procedures for initiation, operation, and monitoring in the support environment

- Initiation of the support environment
- General operation of the support environment
- Monitoring operation of the support environment

Administration, including description of the management and control functions, which include access, security, and access to storage of information

Software modification

TABLE 20B (Continued)
COMPUTER RESOURCES SUPPORT GUIDELINES
(Optional Document – Notional Outline)

Software integration and testing
System and software generation (new operational software) software quality evaluation
Corrective action system, i.e., a description of the recommended method for closed-loop identification and resolution of operational software problems, both modified and unmodified
Configuration management, describing the procedures to be used to maintain strict configuration management of operational software, both modified and unmodified.
Simulation, describing any simulation software or hardware that is required to support software maintenance
Emulation (as above)
Reproduction Procedures
Distribution Procedures
Training
Predicted level/tempo of changes, describing and identifying deficiency corrections and plans for upgrades or technology insertion over a nominal 10-year life cycle following fully operational capability.

20.5 SOFTWARE COST AND RESOURCE ESTIMATION[4]

One of the most challenging tasks in project management is to reliably estimate the size of the software product and resources needed to produce the product. The software estimation process provides the project manager with the estimates to develop the project schedule, to apply resources, and to determine the probable cost of the project.

[4] This section based on the "Report on Project Management and Software Cost Estimation Technologies," April 1995, by Software Technology Support Center (STSC), Hill AFB,UT 84056, Phone 801-777-7703

This section discusses the software estimation process, software tools that are available for sofware estimation, benefits of software estimation, and trends in software estimation technology.

20.5.1 Software Estimation Process

Software estimation should be approached as a major process; it should be well planned, reviewed often, and continually updated. The basic steps required to accomplish software estimation follow:

- identify project objectives and requirements;
- plan the activities;
- estimate product size and complexity;
- estimate effort, cost, and resources;
- develop projected schedule;
- compare and iterate estimates; and
- follow up.

Further information regarding each of these steps is available in the "Report on Project Management Software Cost Estimation Technologies," mentioned in the footnote below.

20.5.2 Software Estimation Methods

The following five methods have been used for many years. Typically, in the past, these methods have been used without computer-based software estimation tools. Now, software estimation tools are available that incorporate these methods:

- Analogy Method. This method compares the proposed project to previously completed, similar projects where actual project development information is known. Data from the completed projects are used to estimate the proposed project. The method's main strength is that the estimates are based on actual project data and past experience. The analogy method's limitations are that similar projects may not exist or that the accuracy of available historical data may be suspect. For example, many DoD weapon system software projects do not have historical precedents.

- Bottom-up Method. This method estimates each component of the software project separately then combines the results to produce an estimate of the entire project. Advantages of this method are listed below:

  — It provides a more detailed and accurate basis for estimation because it deals with low-level components.

— It supports project tracking more directly than other methods because its estimates usually address each activity within each phase of the software development life cycle.

- Top-down Method. This method of estimating starts with the overall characteristics of the software project. The project is then partitioned into lower-level components and life-cycle phases. This method is more applicable to early estimations when only global properties are known. Advantages of this method are shown below:

  — It considers system-level activities (integration, documentation, projects control, configuration management, etc.), many of which may be overlooked in other estimation methods.
  — It is usually faster and easier to implement than the bottom-up method.
  — It requires minimal project detail.

  This method has disadvantages: (1) it tends to be less accurate than other methods; (2) it tends to overlook lower-level components and technical problems; and (3) it provides very little detail for justifying estimates.

- Expert Judgment Method. This method uses the experience and understanding of human experts to provide the project estimates. An advantage of this method is the experience from past projects that the expert brings to the proposed project. The expert also can factor in project impacts caused by new technologies, applications, and languages. Disadvantages are: (1) estimates can be no better than the expertise and judgment of the expert; and (2) it can be difficult to document the factors used by the expert who contributes to the estimate. *The best use of expert judgment is as a complement to other estimation methods.*

- Algorithmic Method. This method uses mathematical formulas to make software estimates. The formulas are derived form research and historical data and use inputs such as source lines of code (SLOC), number of functions to perform, and other cost factors including programming language, design methodology, skill levels, and risk assessments. Advantages of this method include the:

  — ability to generate repeatable results;
  — ease in modifying input data;
  — ease in revising and customizing formulas; and
  — ability to better understand the estimation methods since the formulas can be analyzed.

However, the results can be questionable when estimating future projects that use new technologies. The formulas generally are unable to deal with conditions such as exceptional personnel, exceptional teamwork, and exceptional matches between skill levels and tasks. Additionally, algorithms are usually developed within companies for internal use and may be more reflective of a company's performance characteristics than of software development in general; also, they may be proprietary.

20.5.3 Risks

All known risks associated with a software development project should be defined and weighed, and impacts to project costs should be determined. This information should always be included as part of the software estimation process. Poor software estimates generally result from four major risk areas:

- underestimation of the software size,
- instability in the development environment or processes,
- misalignment of staff skills to required tasks, and
- requirements growth during the software development life cycle.

20.5.4 Trends

New software development processes and products are overcoming traditional software development methodologies. The growing use of fourth-generation languages, commercial software, reuse, and object-oriented development, to name a few, is making significant changes in the way applications are developed within organizations. Consequently, software estimation models are changing; and new approaches and greater flexibility are required in the models.

20.5.5 Typical Input Data for a Top-Down (Parametric) Cost Model

This section illustrates the type of data that would be entered in a top-down software cost model. For illustrative purposes only, the example used is taken from the SEER-SEM model, one of many listed in Table 20D at the end of this chapter.

- <u>Software Configuration Management</u>. Enter the average monthly labor rate for software configuration management personnel only.
- <u>Software Data Preparation</u>. Enter the average monthly labor rate for software data preparation personnel only.
- <u>Software Test</u>. Enter the average monthly labor rate for software test personnel only.
- <u>Software Maintenance</u>. Parameters included in this category are:

  — Years of Maintenance.
  — Separate Sites.
  — Maintenance Growth over Life.
  — Personnel Differences.
  — Development Environment Differences.
  — Annual Change Rate.
  — Maintenance Level.

— Min Maintenance Staff (Optional).
— Max Maintenance Staff (Optional).
— Maintenance Monthly Labor Rate.
— Additional Annual Maintenance Cost.
— Maintenance Start Date.
— Percent To Be Maintained.
— Maintain Total System.

- Years of Maintenance. Number of years for which software maintenance costs will be estimated. Maintenance begins when operational test & evaluation is completed.

- Separate Sites. Number of separate operational sites where the software will be installed and users will have an input into system enhancements.

- Maintenance Growth over Life. The anticipated size growth from the point immediately after the software is turned over to maintenance to the end of the maintenance cycle. Software growth may include additions of new functionality. Major enhancements should be modeled separately as new developments or incremental builds.

- Personnel Differences. Rates the maintenance personnel's capabilities and experience in comparison to the development personnel's capabilities and experience. If maintenance only is being estimated as a separate CSCI, this parameter should be set to Nominal; and the Personnel Capabilities and Experience parameters should be rated individually.

- Development Environment Differences. Rates the quality of the maintenance environment in comparison to the tools and practices used in the development environment. If maintenance is being estimated as a separate CSCI, this parameter should be set to Nominal; and Development Support Environment parameters should be rated individually.

- Annual Change Rate. Average percentage of the software impacted by software maintenance and sustaining engineering per year. This could include changes, revalidation, reverse engineering, re-documentation, minor changes for new hardware, or re-certification.

- Maintenance Level (Rigor). This parameter rates the thoroughness with which maintenance activities will be performed. For example:

Rating	**Description**
Very High	Thorough maintenance for all types of software maintenance activities, including regular documentation updates. Software maintenance is well planned in both the long and short term with frequent reviews of priorities. Dedicated staff assigned for maintenance. Software will remain useful for users and will not degenerate over time.
High	Complete maintenance including maintenance planning and priority review. Software documentation is updated on a semi-regular basis. Software will not degenerate over time.

Rating	Description
Nominal	Average maintenance activity. Short-term planning and prioritization of maintenance activity. Documentation is updated less than once a year (change pages and addenda). Software will become less useful as more time goes by.
Low	Basic maintenance with most activity being reactive to emergencies and problems as they arise. No planning of maintenance activity. Documentation is updated only with change pages and addenda. Software will degenerate over time.
Very Low	Bare-bones maintenance. Nondedicated team doing emergency fixes. Maintenance is performed on an ad hoc, sporadic basis. Little to no documentation update. Software will degenerate rapidly. May also represent sustained engineering effort of a delivered incremental subsequent build.

- Maintenance Staffing. This is the minimum number of personnel who will be assigned to maintain the software. Use this parameter for fixed staffing or level of effort maintenance.
- Maintenance Monthly Labor Rate. This is the average monthly labor rate for maintenance personnel.
- Additional Annual Maintenance Cost. This is any annual throughput maintenance cost.
- Percent To Be Maintained. Percentage of the total that will be maintained. For example, if part of the software is in a read only memory and cannot be changed, exclude this part of the computer program from software maintenance costs by reducing this percentage.
- Maintain Total System. Determines whether total size or effective size should be used to estimate maintenance.
- Software Code Metrics. This parameter category allows user inputs into various software code metrics. These metrics are used to calculate the reliability of the produced code. Since these metrics are normally only available after a development is completed, some models will automatically estimate these metrics internally if no entries are given. Because of this, these code metrics should only be entered if detailed and accurate measurements of the actual code are available from which to collect these metrics. Detailed definitions of these are published in IEEE publications as well as most textbooks encompassing software metrics.

20.5.6 Typical Output Data for a Top-down (Parametric) Model

Table 20C is an example of the output data from a parametric software cost-estimating model. In order to parallel the input data in section 20.5.5, this example is also extracted from the SEER-SEM model. However to reiterate, SEER-SEM is but one of the many models listed in Table 20D and is used for illustrative purposes only.

Table 20C
Illustrative Example of Maintenance Effort and Cost by Year

Base Year: 1994
Fiscal Year Start Month: 1

Fiscal Year	Average Staff Level	Correct	Adapt	Effort Months Perfect	Enhance	Total	Cumulative	Base Year Cost	Base Year Cumulative
1999	6.4	22.7	3.2	20.2	2.8	49.9	49.0	720,887	720,887
2000	5.5	26.4	6.9	24.3	8.3	65.9	114.9	968,532	1,689,419
2001	3.7	9.6	9.1	12.8	12.6	44.1	159.0	648.532	2,337,877
2002	2.9	4.7	8.9	9.2	12.6	35.3	194.4	519,332	2,857,209
2003	2.9	4.7	8.9	9.2	12.6	35.3	229.7	519,332	3,376,541
2004	2.9	4.7	8.9	9.2	12.6	35.3	265.0	519,332	3,895,873
2005	2.9	4.7	8.9	9.2	12.6	35.3	300.4	519,332	4,415,205
2006	2.9	4.7	8.9	9.2	12.6	35.3	335.7	519,332	4,934,537
2007	2.9	4.7	8.9	9.2	12.6	35.3	371.0	519,332	5,453,869
2008	2.9	4.7	8.9	9.2	12.6	35.3	406.3	519,332	5,973,201
2009	2.9	4.7	8.9	3.4	4.6	12.9	419.2	189,113	6,162,315

20.5.7 Software Estimation Tools

Software estimation tools do not guarantee good software estimates. If unreliable software size estimates and attribute ratings are input, then poor estimates will result. This is known as the garbage in/garbage out or GIGO principle. Good estimates are dependent on collecting, refining, and maintaining historical data from current and past projects to provide the necessary inputs required for the software estimation tools. The software development organization should establish a staff that is thoroughly trained in the software estimation process and use of available estimation tools; they should be involved in all software estimates for the organization. Experience and existing tools dictate what software development information needs to be maintained.

Table 20D lists some of the available cost estimation tools available to the PMO staff.

TABLE 20D
SOFTWARE COST ESTIMATION TECHNOLOGY PRODUCT LIST

PRODUCT	VENDOR	PLATFORM
AEM	Koch Productivity Consulting 410-838-8721	DOS/Windows, OS2
CA-Estimacs	Computer Associates Int., Inc. 201-585-6720	PC (286, 386, 486, etc.) MS-DOS, Windows 3.x
CA-FPXpert	Computer Associates Int., Inc. 201-585-6720	MS-DOS
CA-Metrics	Computer Associates Int., Inc. 201-585-6720	IBM, MS-DOS
CA-Planmacs	Computer Associates Int., Inc. 201-585-6720	PC-MS/DOS
CA-Project Navigation	Computer Associates Int., Inc. 201-585-6720	MS-DOS
CB COCOMO	Decisioneering, Inc. 303-337-3531	Mac/Windows, Excel, Lotus 1-2-3
CHECKPOINT	Software Productivity Research, Inc. 617-273-0140	IBM or compatible (386 min) HP7XX & 8XX, Sun SPARC, Windows Rel. 3
COCOMOID	Air Force Cost Center 513-257-4624	MS-DOS
CoCoPro	Iconix Software Engineering, Inc. 310-458-0092	Macintosh
COSTAR	Softstar Systems 603-672-0987	DEC VAX, VAXstation, Micro VAX/VMS, PC-MS/DOS
COSTMODL	COSMIC 706-542-3265	IBM, HP7XX & 8XX, Sun SPARC, Motorola MPC (88000 or 88100)
Crystal Ball	Decisioneering 303-337-3531	Mac/Windows
GECOMO Plus	Marconi Systems Technology 703-263-1260	VMS, Unix OSF Motif, Windows
Micro Man ESTI-MATE	Protellicess Software 310-393-4552	MS-DOS, PC-Windows
PRICE S	Martin Marietta PRICE Systems 800-437-7423	Unix/Motif or MS Windows
Project Base	Kapur International, Inc. 510-275-8000	PC/MS-DOS
Project Bridge	Applied Business Technology Corp. 800-444-0724	MS-DOS/MS Win
REVIC	Air Force Cost Analysis Agency 703-746-5865	MS-DOS

TABLE 20D (Continued)
SOFTWARE COST ESTIMATION TECHNOLOGY PRODUCT LIST

PRODUCT	VENDOR	PLATFORM
SASET	Air Force Cost Analysis Agency 703-746-5865	MS-DOS
SECOMO	IIT Research Institute 315-339-7004	IBM PC, MS-DOS, VAX/VMS 3.2+
SEER-HLC	Galorath Associates, Inc. 310-670-3404	PC-MS/DOS
SEER-SEM	Galorath Associates, Inc. 310-670-3404	IBM PC, Macintosh, SUN, Windows 3.1 or higher, Sys 7, Unix
SEER-SSM	Galorath Associates, Inc. 310-670-3404	IBM PC, DOS 3.0+
SIZE Planner	Quantitative Software Mgt., Inc. 703-790-0055	IBM, PC/Windows 3.1, SUN
SIZE Plus	Marconi Systems Technology 703-263-1260	VMS, Unix OSF Motif, X-Win
SLIM	Quantitative Software Management, Inc. 703-790-0055	IBM PC/Windows 3.1, Windows NT, Windows for Workshops, OS/2
SLIM Control	Quantitative Software Management, Inc. 703-790-0055	IBM PC, Windows for Workgroups, Windows NT, OS/2
SPQR/20	Software Productivity Research, Inc. 617-273-0140	MS-DOS
SWAN	IIT Research Institute 315-339-7004	MS-DOS
VAX Software Project Manager (V.1.2)	Digital Equipment Corp. 800-344-4825	DEC VAX, Micro VAX, VAXstation/VMS, Micro VMS

21

COMMERCIAL AND NONDEVELOPMENTAL ITEM (NDI) LOGISTICS

"To provide for the rapid delivery of major acoustic improvements to the SSN688, SSN 6881 and SSBN 726 class submarines, we have implemented a Program entitled Acoustics Rapid COTS Insertion (A-RCI). This four-phased plan will reduce the time for obtaining operational value from demonstrated technologies. .... A-RCI will implement a COTS based open system approach utilizing commercial processing capacity, which has substantial growth potential. Further, A-RCI results in space and weight reduction, reduced cycle time for future upgrades and development cost savings"

ASN(RDA), before the Subcommittee on Seapower
of the Senate Armed Services Committee, 1996

21.1 DEFINITIONS

Definitions of Commercial Items (CIs) and Nondevelopmental Items (NDIs) describe a broad, generic area that covers material available from a variety of sources with little or no development effort required by the government. These acquisitions provide major benefits as well as challenges to the systems acquisition process and the user. Benefits include: quick response to operational needs; elimination or reduction of research and development costs; application of state-of-the-art technology to current requirement; and reduction of technology, cost, and schedule risks.

These acquisitions present challenges including the possibility that items developed for needs other than DoD's may fail to meet all of the user requirements and mission-performance tradeoffs that are required to gain the advantages of pursuing these alternatives. Additional challenges include providing logistics support, product modifications, and continued product availability. CI and NDI acquisitions benefit the systems acquisition process in reducing risk and development costs. These benefits may be offset, unless carefully balanced by intelligent performance tradeoffs. The following definitions are provided by DoD 5000.2-R (15 March 1996).

21.1.1 Commercial Item

A CI is defined as any item, other than real property, that is of a type customarily used for nongovernmental purposes and that:

- has been sold, leased, or licensed to the general public;
- has been offered for sale, lease, or license to the general public; and

- has evolved through advances in technology or performance that are not yet available in the commercial marketplace, but this item will be available in the commercial marketplace in time to satisfy the delivery requirements stipulated under a government solicitation.

Also included in the definition are services in support of a CI, or a type offered and sold competitively in substantial quantities in the commercial marketplace based on established catalog or market prices for specific tasks performed under standard commercial terms and conditions. This does not include services that are sold based on hourly rates without an established catalog or market price for a specific service performed under standard commercial terms and conditions. Also, it does not include services that are sold based on hourly rates without an established catalog or market price for a specific service performed.

21.1.2 Modified Commercial Item

A modified CI is any modified item that is customarily available in the commercial marketplace and that is made to meet Federal Government requirements. Such modifications are considered minor if the change does not significantly alter the non-governmental function, essential item or component, physical characteristics, and the purpose of the process. Factors to be considered in determining whether a modification is minor include the value and size of the modification and the comparative value and size of the final product. Dollar values and percentages may be used as guideposts, but they are not conclusive evidence that a modification is minor.

21.1.2.3 Nondevelopmental Item

A nondevelopmental item is:

- any previously developed supply item used exclusively for governmental purposes by an agency, state, local government, or a foreign government that has a mutual defense cooperation agreement with the United States;
- any item that fits the first description above, and that requires only minor modification or modifications of the type customarily available in the commercial marketplace in order to meet the requirements of the procuring department or agency; and
- any item that is not in use and that fits the descriptions above.

A succinct version of this definition is provided in Table 21A.

21.2 BACKGROUND

Since the early 1970s, several studies have supported the increased use of NDIs by DoD. The President's Blue Ribbon Commission on Defense Management (the Packard Commission) was a major turning point in the history of NDI acquisition. The 1986 report reviewed and brought new emphasis to earlier studies advocating NDIs. The Commission took the position that "DoD should make greater use of components, systems, and services available off the shelf. It should

develop new or custom-made items only when it has been clearly established that those readily available are clearly inadequate to meet military requirements." Regarding military specifications, the commission asserted that products developed strictly for military use and to military specifications generally cost more than commercial counterparts and that adherence to these specifications was often needless and wasteful. If there is an available commercial counterpart, it recommended that the Defense Acquisition Executive (DAE) require program directors/managers to receive a waiver before using a product made to military specifications. The commission findings were echoed again in the *1989 National Security Review on Defense Management.* Finally, the Congress has implemented specific language concerning use of NDIs in recent authorization and appropriation acts in order to ensure that DoD addresses its NDI concerns. For its part, DoD has provided new guidance on NDI acquisition in DoDD 5000.1 and DoD 5000.2-R of 15 March 1996.

Table 21A

NONDEVELOPMENTAL ITEM: DEFINITION

- Previously developed item used exclusively for governmental purposes by:
  - Federal Agency
  - State or Local Government
  - Foreign Government
- Same as above but with modifications or soon in use.

21.2.4 Requirements Generation

The conception of any acquisition program lies in the identification of a need for a system to meet a military requirement. This need or requirement is expressed by the using Commands in terms of operational requirements documents. Once these requirements are generated and validated, the developing or procurement commands are tasked to find the system or component that will meet the requirement. DoD 5000.2-R states that the Program Manager (PM) shall consider all of the:

> "...prospective sources of supplies and/or services that can meet the need, both domestic and foreign. CIs and NDIs shall be considered as the primary source of supply.
>
> "Market research and analysis shall be conducted to determine the availability and suitability of existing CIs and NDIs prior to the commencement of a development effort, during the development effort, and prior to the preparation of any product description. The PM shall define requirements (including hardware, software, standards, data, and automatic test systems) in terms that enable and encourage offerors of CIs and NDIs an opportunity to compete in any procurement to fill such requirements.

"The PM shall require prime contractors and subcontractors at all levels to incorporate CIs and NDIs or components of items supplied and modify requirements to the maximum extent practicable, to ensure that the requirements can be met by CIs and NDIs. For ACAT I and IA programs, while few CIs meet requirements at a system level, numerous commercial components, processes, and practices have application to DoD systems. CIs supplied shall be based on non-governmental standards and CI descriptions to the maximum extent practicable. Preference shall be given to the use of CIs first and nondevelopmental items second. However, the overriding concern is to use the most cost-effective source of supply. Table 21B shows the hierarchy of solutions to a mission need.

"Use of CIs or NDIs does not exempt the PM from complying with environmental requirements, unless exempted by statute."

Table 21B

HIERARCHY OF SOLUTIONS TO A MISSION NEED

1. Nonmateriel solution: change in doctrine, operational concept, tactics, training and/or organization
2. Use or modification of an existing U.S. Military System
3. Use or modification of an existing commercially developed or allied system that fosters a nondevelopmental acquisition strategy
4. Cooperative R&D program with allies
5. New Joint-Service developmental program
6. New Service-unique development program

21.3 THE LOGISTICS CHALLENGE IN COMMERCIAL/NDI ACQUISITION

Effective logistics poses a challenge in developmental programs, even with all the training and guidance that acquisition personnel receive. Ensuring that logistics is handled effectively in a commercial/NDI acquisition can be a significantly more difficult challenge to materiel acquisition personnel because of the differences in the commercial/NDI acquisition process. Some of the key differences are shown in Table 21C. Since the acquisition lead time is reduced, there is less time available to plan for and develop logistics support. Those logistics activities that normally would occur during the Program Definition and Risk Reduction (PDRR) and the Engineering and

Table 21C

COMPARING CONVENTIONAL AND COMMERCIAL/NDI LOGISTICS MANAGEMENT ACTIONS

Logistics Management Actions:	Conventional (New Development)	Commercial/ Nondevelopmental Item
Define	No use data, requires conceptual/ engineering skills	Fully defined support structure and extensive use data available
Advocate	Analytical studies	Market research and analysis
Influence	Design incomplete – considerable opportunity	Design completed – no opportunity
Refine	Challenging, but possible to refine logistics at same pace as IPT	Need additional time to refine logistics if item is used in new environment
Foster T&E	TEMP interface and $$ will accomplish this	Inputs to test plan first require commercial/NDI support planning
Acquire	Configuration instability can hamper efforts	Stable configuration and use data make the job relatively easy
Provide	Start of lessons-learned process	Extensive set of (non-proprietary, hopefully) lessons learned available
Improve	Modifications and improvements are norm as technology advances	Immediate improvement renders Acq Strategy "Modified Commercial"

Manufacturing Development (EMD) phases must be accelerated to ensure effective support for that item. Unlike a developmental item, with commercial/NDI there may be support in place as well as "real" reliability data and training. These items are being used, broken, and fixed. Additionally, logistics support may be impacted adversely by proliferation of hardware and software since DoD may not be acquiring sufficient technical data and technical/data rights to maintain configuration control of CIs. Also, the influence DoD has on the supplier may be limited by its customer status.

21.3.1 Meeting the Challenge

The logistics problems involved with commercial/NDI acquisition can be overcome, just as they can be overcome in a traditional developmental acquisition. Acquisition personnel must be sensi-

tive to problems and ensure they are addressed early in the acquisition process. They must understand implementing effective logistics, for commercial/NDI will probably require a departure from "normal" procedures of a developmental item's acquisition. Tradeoffs also must be seriously considered when deciding to adopt a commercial/NDI acquisition strategy.

DoD 5000.2-R directs each PM to develop and document an acquisition strategy that will serve as the roadmap for program evaluation from program initiation through postproduction support. The acquisition strategy should state whether organic, contractor, or a mix of organic/contractor logistics support is the most cost-effective and operationally effective approach to support the item. Appropriate tradeoff analyses should be conducted to arrive at the most cost-effective and operationally effective support strategy. Interim contractor support, incremental (block) development and fielding strategies, lifetime contractor logistics support, or full organic logistics support shall be considered and planned during the development of the acquisition strategy and definitized in the solicitation. The departure from "normal" procedures or, rather, the inability to depart from them was highlighted in a 1991 National Security Industrial Association study, "Commercial Off-the-Shelf/Nondevelopmental Items (COTS/NDI) Study," as follows:

> "It is evident that the logisticians...have reviewed and studied the COTS/NDI issue. Apparently because of their paradigms, the results continue to come out the same, namely, that the "standard" way of doing business should not change. Information received from that community leads to the conclusion that the only way to go is buy maintenance and provisioning data and train Army military and civilians for maintenance support...
>
> "What this bears out is that acquisition, fielding, and sustainment of COTS/NDI remains a serious problem for the U.S. Army. A major change in culture is necessary, and that cannot happen quickly. The current methods, procedures, and cuts have been grown, cultivated, and taught since the end of World War II."[1]

The study explains the possible reason for this situation:

> "Life-cycle support, worldwide, is very important to the Army, as the Army can be required to deploy to any location in the world on short (hours) notice. It must be able to keep its equipment and systems operational so as to ensure successful mission accomplishment. The failure or loss of an item of equipment on a critical task could make the difference between mission success or failure. In full recognition of the [SIC] fact, it is easy to comprehend the emphasis placed on life-cycle support. It is also easy to understand why military personnel and civil servants resist change in the methods of getting or planning life-cycle support. Very few people are willing to take a chance to specify COTS/NDI items and contractor support because of the fear that the two will not meet military performance and support requirements."[2]

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[1] NSIA "COTS/NDI" Study, p. 16

[2] Ibid., p. 17

The study further states that existing Army regulations reinforce the "business as usual" mind-set, and there appears to be no differentiation between conventionally developed items and commercial off-the-shelf or nondevelopmental items. It concludes the discussion of life-cycle support by calling for a total paradigm shift through "an innovative environment that tolerates and promotes change by adding emphasis to the use of the existing commercial support system and pipeline for life-cycle support of COTS items of equipment."[3] Additionally, support for all types of equipment must be "tailored" to each item, whether it is developmental or nondevelopmental. Regulation, publications, and training should be developed to support this "tailored" approach; also, there should be increased dialogue between industry and Army acquisition personnel.

In June 1991, the Air Force Systems Command (AFSC) and the Air Force Logistics Command (AFLC) published a Joint study called the "Joint Command Commercial Off-The-Shelf (COTS) Supportability Working Group (CSWG) Final Report." Not surprisingly, the CSWG found similar problems with supporting NDI in the Air Force. The following support approach issues were outlined in the Air Force report:

> "Commercial items, specifically the internal configurations of commercial items, change with the market. The changes are driven by competitive pressures. The changing market allows the Air Force to benefit from item improvement but is also a major source of many of the supportability problems associated with CIs. Over time, the support problems increase as spares, software, and the entire support base evolve with the changing item.
>
> "Additionally, CI acquisition and deployment can be fast paced. Often the acquisition and deployment of CIs outstrip the Air Force's ability to get support to the field on time and keep it current with the changing commercial configuration.
>
> "Support for changing, fast paced commercial acquisitions is complicated by regulations and processes that are geared to developmental items and processes. The Air Force attempts to fit commercial acquisitions into the standard support processes for areas such as provisioning, technical orders, common support equipment, and engineering data."[4]

The CSWG study discusses acquisition strategy issues contributing to inadequate, up-front support planning; engineering approaches in system design and integration that impact supportability; requirements process issues; supply support issues; and "mind-set" issues.

21.4 LOGISTICS CONSIDERATIONS IN THE COMMERCIAL/NDI ACQUISITION PROCESS

In response to increased commercial/NDI acquisition and recognizing potential problems associated with it, the Army included a chapter concerning NDI in AMC/TRADOC Pamphlet 70-2 (Chapter 17). The chapter provides guidance on logistics and other considerations during phases

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[3] Ibid., p. 18
[4] AF COTS CSWG Final Report, p. 5

of an NDI acquisition. It provides NDI-related guidance for each logistics element. The following paragraphs examine aspects of the commercial/NDI acquisition process as discussed in the previously mentioned documents and other studies and reports on the subject.

21.4.1 Market Investigation/Market Analysis

During market investigation conducted by the acquiring agency, logistics support requirements information should be provided to industry. It should include planned maintenance echelons, maintainer proficiency levels, software maintenance plans, limitations on evacuation of repairables, maintenance environment, supply support, training needs, and technical data needs. In their responses, industry should provide information on reliability history, maintainability features, flexibility for government maintenance (licensing), critical interfaces with other sub-systems affecting supportability, maintenance in various environments/conditions, extent of competition for support, warranties, current military and commercial customers, estimated life-cycle costs, and requirements/sources of logistics-related training.

The market investigation should provide sufficient information to allow supportability to be thoroughly considered in the subsequent tradeoff process. However, it is critical in this stage of market analysis that the focus remains on which products are available on the commercial market instead of which technology is available. Failure to do this could result in available technologies from different products being consolidated into a single requirement, making utilization of the commercial support base impossible or, worse, making it impossible to fulfill the requirement all together. Despite the focus on available products, thorough examination of product supportability is required.

Selecting a commercial/NDI solution to an acquisition does not imply that any logistics element can be ignored. Commercial/NDI candidates must be thoroughly assessed during the market investigation so that logistics remains a critical factor in the decision of whether a commercial/NDI strategy is feasible. In arriving at logistics decisions regarding commercial/NDI, it should be kept in mind that the commercial/NDI alternatives might require a departure from traditional methods of acquiring logistics support. Logistics design influence (in order to optimize system supportability) may not necessarily work for an already designed commercial/NDI system. It is, therefore, important that the government considers what has been accomplished in all the logistics elements to assist in the commercial/NDI decision and identify areas requiring more effort.

21.4.1 Coordination with "Test Community"

Concurrent with the market investigation process, the program office prepares the Test and Evaluation Master Plan (TEMP) in cooperation with the test community. It is important to ensure all critical logistics support related requirements are identified so they can be included in subsequent testing. Potential sources of existing data relative to critical logistics support related requirements should be identified. Then, these requirements must be coordinated between logistics personnel representing the user and program office and the testing community for inclusion in the TEMP.

21.4.2 Formulating Support Planning and Acquisition Strategy

At this point, a commercial/NDI acquisition strategy will be developed if appropriate. To ensure logistics considerations are incorporated effectively during the commercial/NDI acquisition process, thorough and coordinated planning for supportability should be developed in conjunction with developing acquisition strategy. Planning for supportability should consider all logistics elements, including establishment of milestones for each element. With a commercial/NDI acquisition, thoroughness is critical in this stage since activities related to both Milestones I and II normally must occur during this phase. Planning for deployment and postproduction support must accentuate the accelerated nature of the program and address potential problems involved with logistics lagging the availability of a commercial/NDI system from the production line.

As one respondent said in an NDI survey, "It takes me 18 to 20 months to do a user and market survey and put on contract a piece of commercial equipment. From contract award, the vendor can usually deliver equipment within 3 to 6 months; it takes nearly 30 months to do all the logistics required for fielding. Logistics is, by far, the 'long pole in the tent'. Technical Manuals (TMs) and Maintenance Allocation Charts (MACs) are the longest, along with parts provisioning and stocking."

During the logistics planning process, analysis should be made regarding the utilization of the commercial/NDI system. Decisions on how the commercial/NDI system will be supported will result from this analysis process. The related decisions must include consideration of the fact that there may not be an ideal solution to support this item. Some aspects of the commercial/NDI support will be less than optimal. It must be remembered that overall benefits of acquiring commercial/NDI may far exceed these specific logistics-related concerns. As long as the concerns are recognized and support planning optimizes the risk they present, effective logistics can be achieved for the life of the commercial/NDI system.

As the logistics planning process occurs, support decisions are incorporated into the overall acquisition strategy. The issue of contractor versus organic support is a critical decision.

There are five system-use factors:

- How will the commercial/NDI be used, i.e., from "as is" to fully militarized modification?
- Where will the commercial/NDI be used, i.e., in what environment – from a fixed/industrial/non-hostile one to a mobile/austere/hostile one?
- What is the projected service life?
- When is the commercial/NDI to be used, i.e., to be deployed immediately or sometime in the future?
- Why is a commercial/NDI being selected; i.e., it is taking advantage of an advancing technology (with changing configurations) or the availability of a proven, stable design?

Each use factor shows a range of support methods. These methods range from no support, which implies disposal upon failure, to full organic support. The methods also include full contractor support and combined contractor/organic support.

It should be emphasized that the utilization of these five system-use factors in the manner described in Figure 21-1 is flexible. For example, even though a commercial/NDI system may be deployed in the future and will have a prolonged service life, contractor support may be desirable. The bottom line is that utilization of these factors assists in considering a support approach and does not represent a rigid method for decision making.

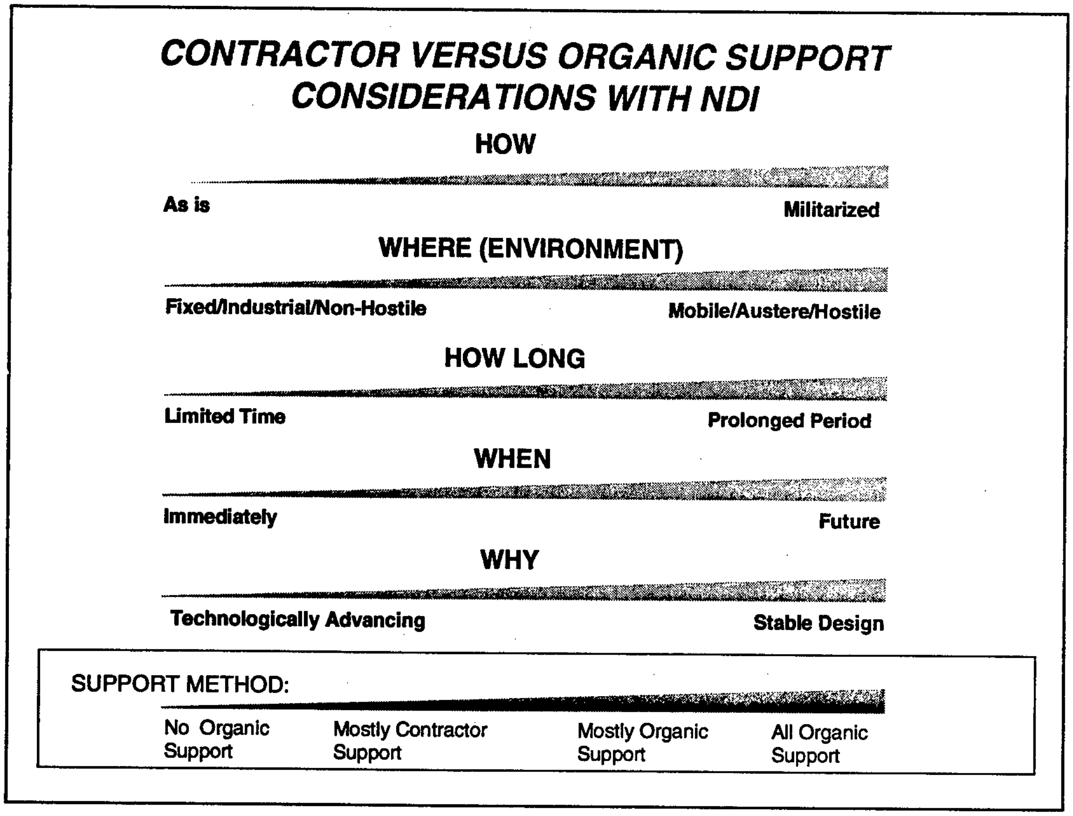

Figure 21-1. Contractor v. Organic Support

21.4.3 Need for Policy Changes

In the Air Force "Joint Command Commercial Off-the-Shelf (COTS) Supportability Working Group (CSWG) Final Report," the CSWG recommended the following:

> "Policy changes: Contractor support is preferred for commercial acquisitions unless mission needs are not met. Because the vendor manages and controls the internal configuration of the commercial item, which is continually changing to meet the demands of the competitive marketplace, contractor support is the approach that best allows the Air Force to support this item. Contractor support permits

configuration changes without the changes impacting the end-user, and without the requirement for a continued update of a military organic support system. In addition, whether it is a vendor or third party that provides the support, the Air Force should accept commercial support because it is often readily available, has a proven track record, and is competitively priced. Contractor provided data, including data on equipment usage and operation, general maintenance tips, recommended spares, etc., should be accepted in contractor format. Special provisions to procure military specification, government formatted data should be avoided.

"When operational requirements dictate an organic support approach, the Air Force should evaluate the requirements for technical data on a case-by-case basis. Commercial item documentation should be limited to data that permits the Air Force to perform minor maintenance on and to operate the commercial item. Source control, specification control, and interface control drawings are recommended for inclusion in the technical data package for commercial items integrated into a system.

"The second policy change should state that vendor support concepts should be applied whether the support is organic or contract. The Air Force should not create a support approach that varies from the commercial mainstream for that item. For example, the Air Force should not remove and replace circuit cards when the vendor concept is to remove and replace black boxes. The Air Force should not perform field level repair of circuit cards when the vendor repairs cards at the depot level. Before the commercial item support concept is selected or changed, a thorough life-cycle cost and effectiveness analysis should be done and all affected commands coordinate on the decision.

"Finally, the Air Force should select the vendor support approach that meets its needs. (Note: The apparent conflict with the previous paragraph is recognized; however, it was not changed to maintain the integrity of the quote.) If the vendor has options for support, or different approaches, the Air Force should select the approach that best meets its needs. These policies require the Air Force to define the support concept early, specify it, and select vendors whose support approaches meet Air Force needs without modification."[5]

21.4.4 Official Recognition of Benefits

Potential benefits of contractor support were recognized by DoD and are included in the latest versions of DoD 5000.1 and DoD 5000.2-R:

"3.3.7 Source of Support: It is DoD policy to retain limited organic core depot maintenance capability to meet essential wartime surge demands, promote competition, and sustain institutional expertise. Support concepts for new and modified

[5] Ibid., p. 6-7

> systems shall maximize the use of contractor-provided, long-term, total life-cycle logistics support that combines depot-level maintenance along with wholesale and selected retail materiel management functions. Life-cycle costs and use of existing capabilities, particularly while the system is in production, shall play a key role in the overall selection process. Other than stated above, and with an appropriate waiver, DoD organizations may be used as substitutes for contractor-provided logistics support, such as when contractors are unwilling to perform support, or where there is a clear, well-documented cost advantage. The PM shall provide for long-term access to data required for competitive sourcing of systems support. The waiver to use DoD organizations must be approved by the MDA."

Utilizing supportability analysis is beneficial during the market investigation, drafting of requirements documentation, and the logistics planning process. Its use can focus on potential problems and lead to sound solutions. It defends development of logistics support concepts. DoD 5000.2R delineates the following criteria for supportability:

> "...analyses shall be conducted as an integral part of the systems engineering process beginning at program initiation and continuing throughout program development. Supportability analyses shall form the basis for related design requirements included in the system specification and for subsequent decisions concerning how to most cost-effectively support the system over its entire life cycle. Programs shall allow contractors the maximum flexibility in proposing the most appropriate supportability analyses.
>
> "Acquisition programs shall establish logistics support concepts (e.g., two level, three level) early in the program and refine them throughout the development process. Life-cycle costs shall play a key role in the overall selection process. Support concepts for new and future weapon systems shall provide for cost effective total life-cycle logistics support."

Figure 21-2 depicts the supportability analysis process for commercial/NDI systems.

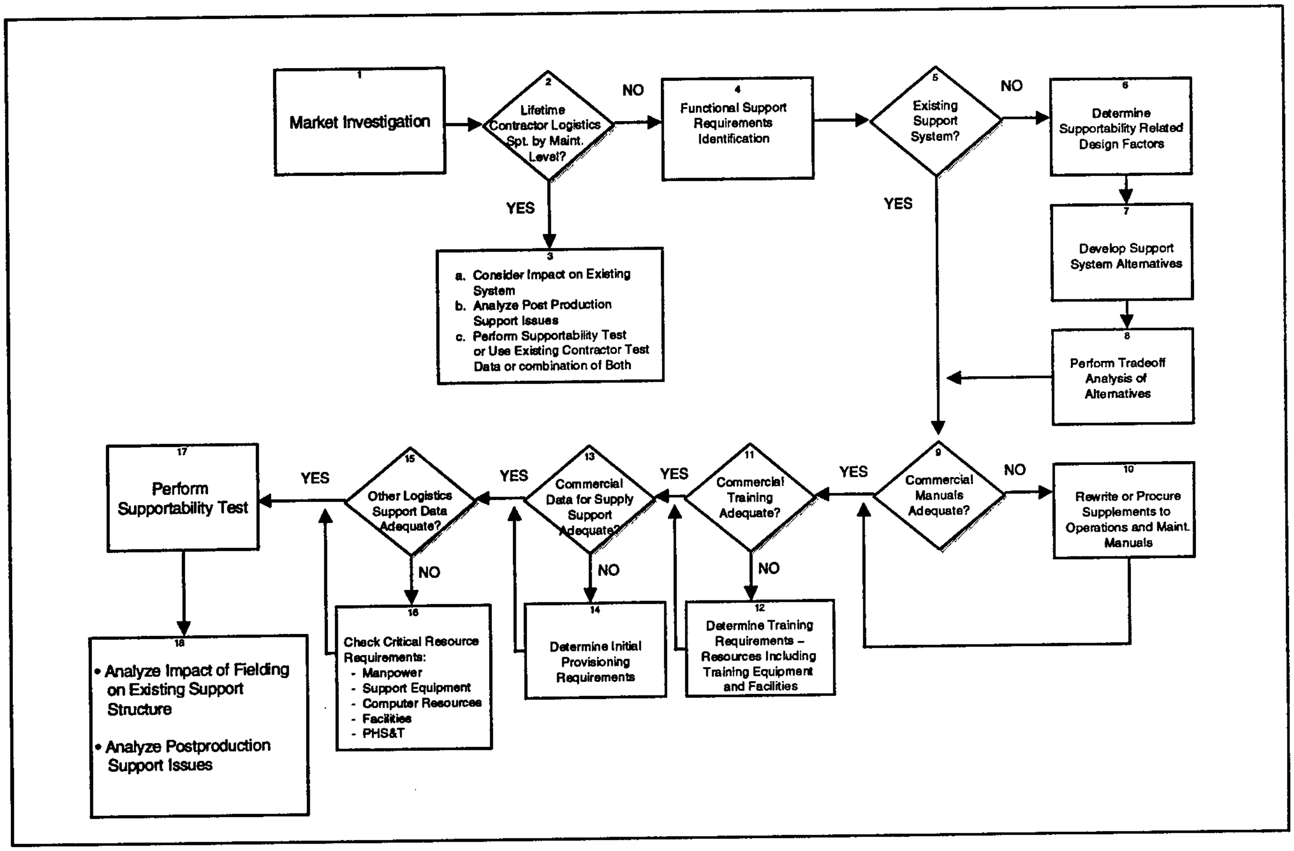

Figure 21-2: Commercial/NDI Supportability Analysis Flow Diagram

21.5 COMMERCIAL/NDI CONSIDERATIONS FOR SELECTED LOGISTICS ELEMENTS

To comprehend fully the logistics issues related to commercial/NDI acquisition, it is beneficial to examine several logistics elements and the commercial/NDI considerations relative to each.

21.5.1 Technical Data

A problem associated with the acquisition of technical data relative to a commercial/NDI acquisition is one of data rights. "Data rights" refer to the authority to use, duplicate, or disclose data. The government acquires data rights to develop specifications, to increase competition and to foster technological development. Industry perceives that the release of data to competitors will erode their competitive edge and has cited this as a major impediment for doing business with the government.

Because data rights are considered "proprietary," commercial firms are reluctant to disclose technical or other data to customers. Commercial contracts do not request this kind of data because it is not a sound business practice. DoD buyers should consider depending more heavily on alternatives such as warranties and training, which is a practice their commercial counterparts engage in

when they resort to acquiring data rights as a last option. If necessary, licensing is available as an alternative to purchasing technical data, e.g., exclusive, semi-exclusive, or nonexclusive licenses.[6]

Only the minimum data needed to permit cost-effective support of research, development, production, cataloging, provisioning, training, operation, maintenance, and related logistics functions over the life cycle of the item should be acquired. Preference should be given to contractor format data and maximum use of commercial technical manuals.

Another option, *data rights escrow*, involves an agreement to deliver a detailed technical data package at a later date, normally when production is nearing completion or when the information no longer represents a competitive advantage for the manufacturer. This is useful primarily when DoD will be maintaining an older model than that carried in the commercial marketplace.

Relative to technical data, the bottom line is that the government must establish its initial support requirements data necessary to fulfill those requirements; determine sources of the commercial/NDI willing or capable of providing required data; and perform any tradeoff analysis required. The government must then adjust or confirm support strategy relative to acquisition strategy; adjust data requirements, if necessary; and procure the data. Implementing a thorough, coordinated, iterative process, based on detailed planning, ensures that this acquired technical data results in an effectively supported commercial/NDI.

21.5.2 Maintenance Planning

The exchange of information between government and industry in the market investigation/market analysis process, with consideration of various factors such as density, environment, availability and format of technical data, warranties, etc., provides for the iterative generation of a maintenance concept as part of the support strategy. The resultant decision to use organic support, contractor support, or a mix as an interim or long-term measure is a product of the tradeoff process.

Preference for contractor support of commercial/NDI is taking hold throughout DoD. Confidence in this approach grew substantially, based upon many cases of successful contractor support during Operation Desert Storm. Dialogue with industry, which determines what is necessary and uses an iterative process of tradeoff analysis considering all pertinent factors, can produce positive results.

21.5.2 Supply Support

The decision on which level repairs will be performed and who will perform them (contractor, organic, mix) will have a direct impact on spares/repair parts requirements. Availability of technical data for reprocurement/spares breakout will influence sources of supply support. The "business-as-usual" tendency is to buy Level III drawings and documentation to the piece-part level. This procedure is often expensive and may lead to procurement of poor-quality parts. More impor-

[6] DSMC, Commercial Practices for Defense Acquisition Guidebook, p. 9-6

tantly, the government's insistence on having such detailed technical data may cause potential offerors of highly desirable commercial/NDIs to refuse to offer their product.

Effective supply support is possible with a commercial/NDI. The LAV-25 program utilized the contractor's Recommended Buy List (RBL), which recommended quantities of spares and repair parts sufficient to support the LAV-25 during the first 12 months of initial fielding. An approach such as this is consistent with Spares Acquisition Integrated with Production (SAIP). This approach, combined with interim contractor supply support, will ensure supportability while the screening and cataloging activities of the provisioning process are taking place.

Concern has been expressed about buying NDIs because the manufacturer may discontinue production and support of the equipment while the item is still used by DoD. Potential problems of this nature should be discussed with potential offerors early in the commercial/NDI acquisition process. If the possibility exists that production and support might cease before a time desirable by the government, several options exist:

- The Government may want to buy upgrades as commercial models evolve. This is sometimes done in unstable technology areas, such as computer hardware and software.
- Another alternative is a onetime purchase of spares. This purchase could be made when the end-item is procured or through an agreement requiring timely government notification so spares can be purchased.
- Finally, arrangements can be made to obtain technical data sufficient to solicit sources of supply support concurrent with the end of the manufacturer's production/support. This concept, called data rights escrow, is often more palatable to manufacturers than providing Level III tech data up front because it does not result in loss of any competitive advantage. The competitive advantage remains because the tech data is transferred at a time when the NDI is no longer a competitive product for the manufacturer.

21.6 CONCLUSION

One of the toughest challenges in commercial/NDI acquisition is ensuring effective logistics. Acquisition lead time is reduced, leaving less time to do the planning for, and development of, organic support. However, commercial/NDI may have support in place since, in many cases, the item is being used, broken, and fixed. Therefore, a support structure, training, and reliability data may already exist.

Potential supportability problems must be addressed early in the commercial/NDI acquisition process. As part of the market investigation, logistics support requirements must be provided to industry. Their feedback will provide the information necessary to facilitate the subsequent tradeoff decisions that must take place.

21.7 REFERENCE

"Buying Commercial & Nondevelopmental Items: A Handbook," April 1996. Available in the *DoD Acquisition Deskbook.*

22
JOINT PROGRAM LOGISTICS

"... it is not always possible to have everything go exactly as one likes. In working with Allies it sometimes happens that they develop opinions of their own."

Winston Churchill,
The Second World War (1950)

22.1 <u>DOD POLICY</u>

The Office of the Secretary of Defense (OSD) and Congress encourage Joint programs. These programs provide opportunities to reduce acquisition and logistic support costs and to improve interoperability of equipment in Joint operations.

DoD 5000.2-R states that:

> "Any acquisition system, subsystem, component, or technology program that involves a strategy that includes funding by more than one DoD Component during any phase of a system's life cycle shall be defined as a joint program. Joint programs shall be consolidated and collocated at the location of the lead Component's program office, to the maximum extent practicable. This includes systems where one DoD Component may be acting as acquisition agent for another DoD Component by mutual agreement or where statute, DoD Directive, or the USD (A&T) or ASD (C^3I) has designated a DoD organization to act as the lead (e.g., USSOCOM, BMDO, DARO). In the case of a designated organization given acquisition responsibilities, the CAE of that organization shall utilize the acquisition and test organizations and facilities of the Military Departments to the maximum extent practicable, rather than create new, unique organizations and facilities. The relationship between the designated organization and the Military Departments and Defense Agencies shall be specified in a Memorandum of Agreement (MOA). Mission needs, operational requirements, and program strategies shall be structured to encourage and to provide an opportunity for multi-Component participation. The DoD Components shall periodically review their programs and requirements to determine the potential for cooperation.
>
> "The JROC, or Principal Staff Assistant (PSA) for ACAT IA programs, shall review and validate ACAT I or ACAT IA Component MNS and ORDs, as appropriate, and shall recommend establishment of joint programs based on their joint potential. DoD Component Heads shall also

recommend establishment of joint programs. The decision to establish a joint program shall be made by the MDA, who shall designate the lead Component as early in the acquisition process as possible. The decision to establish a joint program shall be based on the recommendation of the JROC for programs that shall be reviewed by the Defense Acquisition Board (DAB), the recommendation of the functional PSA and Assistant Secretary of Defense for Command, Control and Communications (ASD (C3I)) for programs that shall be reviewed by the Major Automated Information Systems Review Council (MAISRC), or the recommendation of the DoD Component Head (or a designated representative) for all other programs.

"The designated lead DoD Component Head shall select a single qualified program manager for the designated joint program. The selected joint program manager is fully responsible and accountable for the cost, schedule, and performance of the system development. In cases where the joint program is a consolidation of several programs with multiple Component program managers, the joint program manager retains responsibility for overall system development and integration.

"A designated joint program shall have one quality assurance program, one program change control program, one integrated test program, and one set of documentation and reports to include one Joint ORD, one Test and Evaluation Master Plan (TEMP), one APB, one DAES, one Quarterly Report for ACAT IA programs, and one Selected Acquisition Report (SAR) for ACAT I programs. The documentation for milestone reviews and periodic reports shall flow only through the lead DoD Component acquisition chain, and shall be supported by the participating DoD Components. Unless otherwise directed by the MDA or agreed to through an Memorandum of Agreement (MOA) signed by all Components, the lead DoD Component shall budget for and manage the common RDT&E funds for assigned joint programs. Individual DoD Components shall budget for their unique requirements. Inter-Component logistics support shall be utilized to the maximum extent practicable, consistent with effective support to the operational forces and efficient use of DoD resources.

"A lead organization shall be designated to coordinate all operational test and evaluation involving more than one DoD Component. A single report on operational effectiveness and suitability will be produced.

"DoD Components may not terminate or substantially reduce participation in joint ACAT ID programs without the approval of the USD (A&T). Before any such termination or substantial reduction is approved, the proposed termination or substantial reduction shall be reviewed by the JROC.

"The USD (A&T) may require a Component to continue to provide some or all of the funding necessary to allow the joint program to continue in an efficient manner after approval of a Component request to terminate or substantially reduce that Component's participation (10 USC §2311(c)29). Substantial reduction is defined as a funding or quantity decrease of 50% or more in the total funding or quantities in the latest President's Budget for that portion of the joint program funded by the Component seeking to reduce its participation."

22.2 LOGISTICS SUPPORT

Logistics management of joint programs is similar to that of single Service programs, with one major exception — joint program management requires the accommodation of each participating Service's unique requirements resulting from differences in equipment deployment, mode of employment, and support concepts.

In Joint programs, logistics is often the most serious planning constraint. It is important to understand the logistics policies and procedures of both the lead Component and the participating Component to field a sustainable system successfully. Continuous Acquisition and Life-Cycle Support (CALS) should be considered for integration into Joint programs. Failure to achieve logistics agreements with Component logistics chiefs can lead to mandatory reviews and program turbulence. Logistics support plans may be prepared to document the required logistics support if desired by the PM or as advised by the IPTs.

22.3 LOGISTICS OBJECTIVES

Logistics management objectives of joint programs are to:

- realize economies by Joint performance of logistics planning, analysis, and documentation;
- satisfy essential logistic support needs of each Service; and
- effectively attain established readiness and supportability objectives.

22.4 MANAGEMENT ISSUES

There is no overall single structure for the management of Joint programs. The military services should seek to build a structure that responds rapidly to decisions of the lead Service PM and LM and provides a direct information path conveying the requirements of each military service to the PM. Typical staffing of a Joint program office includes the following considerations:

- The lead Service typically establishes a staffing document for the program office; representatives of the participating Services fill the positions. The staffing docu-

ment also designates key positions for the senior representative of each participating Service.

- The participating Services normally assign personnel to fill identified positions in the jointly staffed program office. The senior representative assigned to the program office reports directly to, or has direct access to, the PM and also functions as the participating Service's representative on all issues pertaining to that Service.

- The lead-Service PM usually establishes an IPT, which includes members from the lead and participating Services. The purpose of the IPT is to accomplishment all logistics functions, including the performance of all logistic support analysis for the Joint program.

- Each participating Service normally designates a PM to support the lead-Service PM.

22.5 DOCUMENTATION OF JOINT PROGRAMS

Initial program documentation, beginning with the Mission Need Statement (MNS), is customarily prepared by the Service that first identifies a mission deficiency that cannot be satisfied by a non-material solution. The MNS is prepared prior to establishment of a program. It is forwarded for validation of the need and consideration of Joint potential to the Service's operational validation authority or, for programs with potential to become major defense programs, to the Joint Requirements Oversight Council (JROC). Joint potential should be considered during MNS development including the identification of needs that may cross Service boundaries and coordination with the Services affected concerning the potential for a Joint program. Significant logistics constraints should be clearly identified in the MNS.

The MNS will be further considered by the Milestone Decision Authority (MDA) at Milestone 0 to determine if it justifies further effort. If so, a studies phase will be initiated to identify and evaluate alternatives to meet the deficiency. Normally, an acquisition program, per se, will not yet exist. The Service initiating the MNS will bear responsibility for developing appropriate documentation for the program initiation decision at Milestone I. Some level of support would normally be provided by the other Services if the program has been identified as one with Joint potential. Full consideration of other Service requirements, operational concepts, and logistics support systems is crucial during this study phase. Many of the basic logistics system design decisions are made here.

Once a joint program is formally established at MS I, a lead Service (normally, but not always, the Service that initiated the MNS) will be designated. From that point forward, the lead Service has primary responsibility for all program documentation. Joint program milestone documents are single documents with separate appendices, when required, to support Service-peculiar requirements.

2.6 LOGISTICS FUNDING FOR JOINT PROGRAMS

Each participating Service uses its own Service channels to identify program requirements to OSD. However, the Joint PM maintains overall responsibility for identification of total funding requirements and their inclusion in a Joint Program Funding Plan. The Joint PM also consolidates contracting requirements and contract awards for the entire development and production program. The participating Services transfer the required obligational authority to the Joint Program Office or that office's supporting command for this purpose.

22.7 UNIQUE LOGISTICS REQUIREMENTS

As previously stated, the Services will often operate the systems with differing operating profiles, supply, maintenance support concepts, and unique support equipment. Techniques to accommodate essential Service — unique requirements within the framework of common approaches are discussed in the subsections below.

22.7.1 Support Analyses

Logistics Managers (LMs) of a Joint-Service Program should endeavor to reach agreement on common models for each analytic technique applied to the Joint system. Use of common models will reduce the total analytical effort and also reduce differences in the results obtained. Some differences will remain due to Service variations in logistic parameters, e.g., order and ship time, and maintenance concepts.

22.7.2 Technical Publications

The Services have different requirements for technical publications, manuals, and orders. In addition to the variations in support concept, operational role, and configuration mentioned in the previous paragraph, there could also be differences in the reading comprehension levels of the target audience. The Services generally have been successful in accommodating those differences in Joint-use technical orders and technical manuals, especially when the Joint approach begins at program initiation. Reading comprehension levels occupy a range rather than a precise point value; the Services seek a single target level that satisfies the needs of each Service. Other differences are covered in the body of the specific publication or in Service supplements.

22.7.3 Training

Training requirements vary. The Services employ different skill specialty code systems as well as different maintenance concepts. Single location training for a Jointly used system can still be cost-effective and should be considered early in the planning cycle. As one example, Air Force and Army personnel receive common maintenance training on the TSC 94 and TSC 100 satellite terminals at the Army's Ft. Gordon training facility.

22.7.4 Depot Maintenance Interservicing (DMI)

DMI studies seek to avoid unnecessary duplication of facilities and equipment among the Services. The studies have been performed effectively for both single Service and multi-Service new starts. Interservicing plans for Joint programs should be addressed in the Joint logistics plan. This approach has been applied very effectively on Joint programs. The TRI-TAC Program develops tactical communications systems used by the Army, Navy, Air Force, and Marine Corps. The PM has identified TRI-TAC items to be managed by individual Services. The designated Service then provides depot support for all users of that system.

22.8 SUMMARY

- Joint implementation of logistics planning, analyses, and documentation can reduce total logistics support costs and meet essential needs of each Service.

- As with single-Service programs, effective Joint logistics programs require early planning starting prior to Milestone 0 and continuing during the Concept Exploration phase and beyond.

- Jointly staffed program offices and effective inter-Service communication have been major contributors to the success of Joint program management.

23

INTERNATIONAL PROGRAM LOGISTICS

Give us the tools, and we will finish the job.
Winston Churchill
BBC broadcast, February 9, 1941.

23.1 INTERNATIONAL PROGRAMS SCOPE

This chapter provides a brief overview of the major logistic aspects of international programs. For purposes of this guide, international programs will be limited to certain activities that broadly fit within the categories listed below. Some overlapping exists in these categories depending on organizational view or perspective of a given international program, i.e., congressional oversight view, program administrative responsibilities within DoD, year-to-year wording within federal law, funding legislation, etc. The categories are:

- security assistance,
- international armaments cooperation,
- Joint Military arrangements and operations with allied nations, and
- direct commercial sales.

23.2 SHORT DEFINITIONS OF INTERNATIONAL PROGRAMS

- International logistics is the planning, negotiating, and implementation of supporting logistics arrangements between nations, their forces, and agencies. It includes furnishing logistics support (major end items ...) to, or receiving logistics support from, one or more friendly foreign governments ... with or without reimbursement. It also includes planning and actions related to the intermeshing of ... forces on a temporary or permanent basis. International logistics involves planning ... to meet requirements of ... forces. (See Reference 1 at Section 23.5.)

- Security assistance is a group of programs authorized by the Foreign Assistance Act of 1961, as amended, and the Arms Export Control Act (AECA), as amended, or other related statutes by which the United States provides defense articles, military training, and other defense-related services by grant, credit, cash

sale, lease, or loan, in furtherance of national policies and objectives. (See Reference 1 at Section 23.5.)

- International armaments cooperation describes DoD efforts focused on international cooperative research, development, test and evaluation; joint production resulting from cooperative R&D programs; DoD procurement of foreign equipment technology or logistic support; and, testing of foreign equipment. (See Reference 2 at Section 23.5.)

- Joint Military arrangements and operations with allied nations: Logistic "transfers" that come into play during combined exercises, training, deployments, operations or other unforeseen contingencies. Transfers are exercised by unified and Component commanders under the authority of acquisition and cross servicing agreements (North Atlantic Treaty Organization Mutual support Act of 1979, as amended). This subject is addressed in Section 23.3.3.1, below. (See Reference 2 at Section 23.5.)

- Direct commercial sales: A sale of defense articles or defense services made under a Department of State-issued license by U.S. industry directly to foreign buyer, and which is not administered by DoD through Foreign Military Sales (FMS) procedures. This subject is addressed in Section 23.4.3.2, below. (See Reference 1 at Section 23.5.)

23.3 COOPERATIVE LOGISTICS

23.3.1 Introduction

Cooperative Logistics refers to any cooperation between the U.S. and allied or friendly nations or international organizations in the logistical support of defense systems and equipment used by the cooperating Armed Forces. Cooperative logistics is a logical extension of the acquisition process, but being also a substantial part of military operations, much of the implementation process involves security assistance and FMS processes and procedures. Even though some of the processes described in this section, are under the cognizance of the Defense Security Assistance Agency (DSAA), they are included here for completeness and will be noted again in Section 23.4, Security Assistance.

Cooperative logistics support includes:

- Logistics Cooperation International Agreements (IAs), used to improve sharing of logistics support information and standards and to monitor accomplishment of specific cooperative logistics programs,

- Acquisition and Cross Servicing Agreements (ACSAs),

- Host Nation Support (HNS),

- Cooperative Military Airlift Agreements (CMAAs),
- War Reserve Stocks for Allies (WRSAs),
- agreements for acceptance and use of real property or services, and
- standardization of procedures under America/Britain/Canada/Australia/New Zealand (ABCANZ) auspices.

Also included are agreements focusing specifically on logistics and other defense cooperation agreements. Such agreements are those recently concluded (1995/96) with several Middle Eastern countries. In these agreements, the countries furnish logistics support to the U.S. Forces deployed during regional contingencies.

23.3.2 Legal and Policy Basis

The North Atlantic Treaty Organization Mutual Support Acts of 1979 (dated 4 August 1980), as amended (Title 10 U.S.C. §2341-2350), is now known as the Acquisition and Cross Servicing Agreement (ACSA) Authority. It provides two distinct, although not entirely separate, provisions for cooperative logistics support. Title 10 U.S.C. §2341 provides acquisition-only authority and Title 10 U.S.C. §2342 provides cross-servicing authority, which includes both acquisition and transfer authority. For further details on the authority granted DoD under these laws, read Chapter 11 of the *International Armament Cooperation Handbook* (publication details given at Reference 2, Section 23.5).

23.3.3 Cooperative Logistics Support Agreements

DoDD 2010.9 provides complete details on responsibilities and procedures for acquiring and transferring logistics support, supplies, and services under the authority of Title 10 U.S.C. A brief overview of the most common types of general logistic agreements follows.

23.3.3.1 <u>Acquisition and Cross Servicing Agreements (ACSAs)</u>. These provisions, collectively referred to as ACSAs, are applicable worldwide, not merely to NATO nations. There must be a cross-serving agreement and implementing arrangements (DoDD 2010.9) in effect prior to actual transfers. Chapter 98 of DoD 7220.9-M, *DoD Accounting Manual*, gives information, record-keeping requirements, and reporting procedures. The ACSAs must primarily benefit the interest of DoD forward-deployed Commands and Forces. The ACSAs are not grant programs. DoD acquisition personnel must ensure ACSAs are not used as a routine source of supply for a foreign country. Routine foreign requests for desired U.S. defense articles and services should be addressed through FMS procedures in accordance with the *Security Assistance Management Manual*.

Categories of logistics support, supplies, and services that can be provided under ACSAs are defined in Title 10 U.S.C. §2350.

23.3.3.2 Host Nation Support (HNS). HNS is civil and military assistance (material, personnel, or services) rendered in peace or war by a host nation to allied or friendly forces and organizations located on or in transit through its territory. HNS agreements are normally pursued by unified and Component commands under overall direction of the Joint Chiefs of Staff (JCS) and the Deputy Under Secretary of Defense (Logistics). A broad logistics area is addressed within HNS. Follow-on arrangements and joint planning for logistics lines of communications are particularly important to ensure continued materiel flow in support of deployed Forces in emergency agreements.

23.3.3.3 Cooperative Military Airlift Agreements (CMAAs). Title 10 U.S.C. §2350c authorizes SECDEF, after consulting with the Department of State, to enter into cooperative military airlift agreements with allied countries. Subject to reimbursement and other provisions, these agreements cover transporting foreign military personnel and cargo on aircraft operated by or for the U.S. Armed Forces in return for reciprocal transportation for the U.S.

23.3.3.4 War Reserve Stocks For Allies (WRSA). This program allows for the stockpiling of U.S.-owned war reserve materiel during peacetime to ensure that the U.S. is able to supplement selected allies' sustainability during wartime until they can be resupplied. Any nation hosting such a stockpile is expected to fund storage, maintenance, in-country transit, and other WRSA-related costs. The Congress limits the value of assets transferred into WRSA stockpiles located in foreign countries. In any fiscal year, the amount is limited to the security assistance specified in authorizing legislation for that same fiscal year.

23.3.3.5 Acceptance and Use of Real Property. Title 10 U.S.C. §2608 authorizes DoD Components to accept real property, service, and supplies from a foreign country for support of any element of the U.S. Armed Forces in an area of that country.

23.3.4 Cooperative Logistics Summary

Each participant or party benefits when involved in a cooperative logistics agreement. The benefits can be tangible, such as the support the U.S. Naval vessels receive when in a foreign port; or the benefits can be intangible, such as the implied benefit to the foreign nation of having a visible U.S. Naval presence in the region. Other cases are more obviously "quid-pro-quo": cross-servicing agreements, in which each party receives the equivalent of the materiel or services provided to the other. Besides the obvious material benefit, such agreements have the effect of creating relationships between the parties, which it is hoped will serve to strengthen political bonds. DoD acquisition personnel involved in research, development and acquisition activities should be aware of and support such efforts. They should ensure the cooperative support mechanisms described above are used in an appropriate manner to support forward-deployed Forces, rather than as a means to avoid use of FMS or other armaments cooperation mechanisms described in this chapter.

23.4 SECURITY ASSISTANCE

23.4.1 Introduction

The following material briefly addresses, in general terms, the complex and changing subject of security assistance. *The Management of Security Assistance* (See Reference 1, Section 23.5) addresses four security assistance program Components that require U.S. Government funding and two Components that do not use U.S. dollars. This section will summarize these six programs. Also, the referenced publication notes that, "The DoD does not have a separate logistics system to support foreign military requirements resulting from security assistance efforts. Rather, these requirements are met within existing DoD logistics systems."

Security assistance program components include:

- Foreign Military Sales (FMS) Program and Foreign Military Construction Sales (FMCS) Program (not U.S. Government funded),
- Direct Commercial Sales (DCS) licensed under the AECA, (not U.S. Government funded),
- The Foreign Military Financing Program (FMFP),
- The International Military Education and Training (IMET) Program,
- The Economic Support Fund (ESF), and
- Peacekeeping Operations (PKO).

23.4.2 Legal and Policy Basis

Quoting from *The Management of Security Assistance* (Reference 1, Section 23.5), "Security assistance, as a U.S. Government program, is governed by U.S. statutes. The primary or basic laws are the Foreign Assistance Act (FAA) of 1961, as amended, and the Arms Export Control Act, as amended. Funds are appropriated for security assistance in the annual Foreign Operations, Export Financing, and Related Programs Appropriation Act. Notwithstanding certain security assistance sales programs, such as foreign military cash sales and commercial sales which do not involve funding authorizations or appropriations, the Congress still has an interest in these programs and has, over the years, incorporated certain reporting and control measures in the law affecting these as well as appropriated program."

23.4.3 Security Assistance Programs/Logistics

23.4.3.1 Foreign Military Sales and Foreign Military Construction Sales. FMS is a nonappropriated program through which eligible foreign governments purchase defense articles, services, and training from the U.S. Government. The purchasing government pays all costs that may be associated with a sale. In essence, there is a signed government-to-government agreement, normally documented in a Letter of Offer and Acceptance (LOA). Each LOA is commonly referred to as a "case" and is assigned a unique identifier for accounting purposes. Under FMS, military articles and services, including training, may be provided from DoD stocks or from new procurement.

Cooperative Logistics Supply Support Arrangements (CLSSAs) are FMS agreements for the furnishing of secondary items from the U.S. logistics system to a country in support of specific major end items/systems. DoD considers the CLSSA to be one of the most effective means to replenish the in-country stocks of spares and repair parts that were initially furnished with end items of equipment. FMS CLSSA agreements set out terms under which DoD provides supply support for a common weapon system to a foreign government or international organization on a basis equal to that provided to U.S. Forces. Availability of such support is of paramount importance in promoting interoperability as well as in marketing U.S. manufactured weapon systems. Department of Defense manual (DoD-M) 5105.38M provides guidance for CLSSAs.

FMCS, as authorized by the AECA, involves the sale of design and construction services to eligible purchasers. The construction sales agreement and sales procedure generally parallel those of FMS.

23.4.3.2 Direct Commercial Sales Licensed under the AECA. The FAA includes direct commercial sales as an element of security assistance for congressional oversight purposes. These are sales made by U.S. industry directly to a foreign buyer. Unlike FMS, direct commercial sales transactions are not administered by DoD and do not involve a government-to-government agreement. Rather, the U.S. Governmental "control" procedure is accomplished through licensing by the Office of Defense Trade Control in the Department of State.

23.4.3.3 The Foreign Military Financing Program. The program consists of congressionally appropriated grants and loans that enable eligible foreign governments to purchase U.S. defense articles, services, and training through FMS or direct commercial sales channels.

23.4.3.4 The International Military Education and Training Program. This program provides training in the United States and in overseas U.S. military facilities to selected foreign military and related civilian personnel on a grant basis. It also includes participation by national legislators, who are responsible for oversight and management of the military.

23.4.3.5 The Economic Support Fund. This fund is to promote economic and political stability in areas where the United States has special political and security interests and where the U.S. has determined that economic assistance can be useful in helping to secure peace or to avert major economic or political crises. The ESF can be made available on a grant basis for a variety of economic purposes, including balance of payments support, infrastructure and other capital and technical assistance development projects. The United States Agency administers ESF for International Development (AID) under the overall policy direction of the Secretary of State.

23.4.3.6 Peacekeeping Operations. For the past several years, PKO provided funds for the Multinational Force and Observers that implemented the 1979 Egyptian-Israeli peace treaty and the U.S. contribution to the United Nations Forces in Cyprus. The funding allocations for FY 1996 and 1997 support the African Crisis Response Force, Haiti, Multinational Force and Observers, and the Europe Regional/Organization for Security and Cooperation in Europe, plus several other programs. The Congress has shown interest in a wide range of similar programs that may be funded in the future while funding of existing programs may terminate.

23.4.4 Security Assistance Logistics Summary

Logistics is the element of security assistance that has allowed it to function as a major instrument of our national security and foreign policy. As noted in *The Management of Security Assistance* (Reference 1, Section 23.5), security assistance serves U.S. interests by assisting allies and friends to acquire; maintain; and, if necessary, employ the capability for self-defense. Also, for countries in regions in which the U.S. has special security concerns, such assistance helps them attack the causes of economic and political instability.

23.5 REFERENCES

1. *The Management of Security Assistance*, Defense Institute of Security Assistance Management, Wright-Patterson AFB, Ohio, Sixteenth Edition, April 1996.

2. *International Armaments Cooperation Handbook*, Office of the Deputy Under Secretary of Defense (International and Commercial Programs), June 1996.

3. *The DISAM Journal of International Security Assistance Management*, Vol. 19, No. 2, Winter 1996-97.

PART V

IMPLEMENTING LOGISTICS

24
PRODUCTION

You can run but you cannot hide from logistics.
Truism

24.1 LOGISTICS OBJECTIVES

The logistics objectives during the production phase are to ensure that approved supportability design requirements, i.e., such as Reliability and Maintainability (R&M), are achieved in the early production articles; and they also ensure that planned logistics support resources are defined and adequately funded to achieve the system readiness objectives. The Logistics Manager (LM) should insist on evidence of demonstrated R&M, a producible design, proven repeatability of manufacturing procedures and processes, and logistics support verified in operational testing. (See Table 24A.)

The production phase is an extremely challenging period. Some programs may not succeed in production, in spite of having passed the required milestone design reviews. Reliability and support characteristics that are not "designed-in" cannot be "tested-in" or "produced-in." There may be unexpected failures during the test program that require design changes. The introduction of these changes can impact quality, producibility, supportability, and can result in program schedule slippages. The LM must exercise strong configuration management discipline during this transition period to ensure that the changes incorporated in the system are properly reflected in the support system deliverables.

TABLE 24A SUPPORT ACTIVITIES DURING PRODUCTION
• Verify R&M objectives. • Monitor production of prime and support hardware/ software/GFE. • Coordinate and provide all items of support. • Update support and deployment planning. • Obtain operational feedback ASAP. • Consider logistics implications and testing of ECPs. • Monitor training programs.

The transition process and early stages of production are impacted by:

- design maturity – a qualitative assessment of the implementation of concurrent and effective design policy;
- test stability – the absence or near absence of anomalies in the failure data from development testing; and
- certification of the manufacturing processes – includes both design for production and proof of process. (Proof of process occurs during pilot production, low-rate initial production, or other "proof of concept" methods used prior to rate buildup.)

24.2 VARIABILITY-REDUCTION PROCESS

Variability-Reduction Process (VRP) is a disciplined design and manufacturing approach aimed at meeting customer expectations and improving the development, manufacturing, and repair processes while minimizing time and cost. The traditional approach to improving a product is tightening tolerances and increasing inspections. The alternative VRP approach seeks to reduce causes of harmful variation in the production process and minimize the effects of the variation on reliability and repeatability of the system.

24.2.1 Support Readiness Reviews

The PM or LM should consider support readiness reviews to address all logistics elements. The number of reviews and the topic sequence depend on the nature of the program. Depending on the system under consideration and the phase of the program, some elements will be more critical than others. The emphasis on key program issues will have to be tailored accordingly.

Early support readiness reviews should be incorporated in Preliminary Design Reviews (PDRs) and Critical Design Reviews (CDRs), where the LM has an active role in establishing system and development specifications. Logistics risk areas that were revealed during the PDR and CDR should be prime considerations during later support readiness reviews. The LM should participate in these reviews through an appropriate Integrated Product Team (IPT).

24.2.2 Tasks, Activities and Deliverables

The quality and validity of many of the products of the supportability analyses are put to the test in the production phase. Early validation of the output from the analyses provides confidence in the quality of the analytical side of the process. As the program enters the production phase, a lengthy list of problems requiring resolution by the LM may surface. Examples of these problems include inadequate support equipment; late ordering of spares; inadequate training; documentation that is not to the latest configuration; unproven

facilities; and insufficient sets of check-out equipment to simultaneously support production testing, quality assurance standards, and deployment.

24.2.3 Support Requirements Review during the Production Phase

The LM should take stock of the lessons learned from the results of the Engineering and Manufacturing Development (EMD) phase by conducting a support requirements review before recommending that the program proceed to the production phase. Some questions to ask follow:

- Have critical supportability design deficiencies identified during Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) been corrected, or have solutions been identified that can be applied before deployment?
- Have logistics elements (support equipment, technical manuals, etc.) been fully evaluated in a representative operational environment?
- Have deficiencies been corrected, or can they be corrected before deployment?
- Have quantitative requirements for logistics elements (e.g., maintenance staffing and initial provisioning) been determined?
- Is sufficient funding included in the Program Objective Memorandum (POM)?
- Can the staffing required to support the system be satisfied by the Services personnel projections?
- Will production lead times for the logistics elements support the planned production and deployment schedules?
- Have tests and simulations confirmed the attainability of system readiness thresholds within the target levels for Operations and Support (O&S) costs?
- Have plans for interim contractor support, if applicable, and transition to organic support been prepared?

If these issues have not been resolved, the LM should develop a recovery plan and/or recommend further system development.

24.2.4 Logistics Manager's Priority Tasks during the Production Phase

The primary purpose of the acquisition process is to deploy systems that not only perform their intended functions but also are ready to perform these functions repeatedly without burdensome maintenance and logistics efforts. The successful deployment of a reliable

and supportable system requires that the LM provide strict watchdog management during the production phase to ensure that adequate technical engineering, manufacturing disciplines, and management systems are applied to the logistics elements and supportability features of the system. Priority items for the LM include:

- providing timely and adequate funding for all logistics elements;

- involving logistics specialists in the preparation of comprehensive hardware and software design specifications;

- continuing to conduct supportability analyses;

- ensuring logistics input to configuration control and the comprehensive assessment of the impact of changes on all logistics elements; and

- establishing a technical management system for tracking support equipment reliability, configuration control, and compatibility with end item hardware/firmware/software.

25
DEPLOYMENT/FIELDING

Deployment: As used herein, deployment is a generic term covering the activities known as fleet introduction in the Navy, site activation in the Air Force, materiel fielding in the Army, and fielding in the IT/AIS community.

25.1 HIGHLIGHTS

In this Chapter, several deployment/fielding highlights will be discussed, including:

- deployment planning requirements and schedules;
- deployment coordination and negotiation requirements;
- the deployment plan, agreement and certification; and
- deployment process management.

25.2 INTRODUCTION

25.2.1 Purpose

This Chapter will provide a managerial overview of the actions required to successfully deploy a new or modified system.

The term deployment, as used here, includes fielding, turnover, hand-off, fleet-introduction and other terms used by the Services for the initial introduction of a system to operational commands. Deployment planning, execution, and follow-up requirements will be discussed. They cover the period from the Concept Exploration (CE) phase until the last unit is operational.

25.2.2 Objective

The deployment process is designed to turn over newly acquired or modified systems to users who are being and have been trained and equipped to operate and maintain the equipment. All organic or contractor-operated elements of logistics must be in place at appropriate levels at the time of deployment. Although it may seem a straightforward process, deployment is complex and can be costly if not properly managed. When properly planned and executed, deployment can make a major contribution toward mission achievement if planned levels of unit readiness are met, planned costs are not exceeded, and logistics turmoil is minimized.

25.3 MANAGEMENT ISSUES

25.3.1 Scope

Deployment challenges the Service logistics organization with providing adequate support to a system when custody of that system shifts to a user or operating command. At that point, the Service logistics capability may be augmented for various periods or perpetually by a range of contractor-provided services. In fact, DoD 5000.2-R directs that these services be used for appropriate programs by stating, "Where they are available, cost-effective, and can readily meet the user's requirements, commercial support resources shall be used."

First unit Initial Operational Capability (IOC), a possible start date for deployment resources to be in place, may range from the first day of custody of the system hardware to some later date when unit training has been completed and a readiness inspection is satisfactorily passed. The type of deployment program may range from introduction of thousands of combat vehicles over a 10-year period to the staged delivery and acceptance of a single aircraft carrier. Regardless of the number of items and the length of the deployment schedule, there must be a comprehensive, coordinated deployment plan. This plan must contain realistic lead times that are supported by adequate funds and staff and that have the potential for rigorous execution. Applicable elements, among those identified in Figure 25-1, must be available on schedule or the system will not be operational.

Although a deployment schedule may be established at Milestone I, subsequent adjustments are possible and should be considered, particularly in the early stages of a program when a greater range of flexibility exists. In later stages of the acquisition process, the failure to meet a logistics milestone can translate either into a costly deployment delay or deployment of a system that cannot meet readiness goals. Either one will result in reduced mission capability.

25.3.2 Planning

Deployment should not be thought of as simply delivering equipment. There is a need for consideration of manpower, personnel and training requirements, establishment of facilities, placement of system support, use of contractor support, data collection and feedback, scheduling, and identification of funds. Planning for deployment and using an Integrated Product Team (IPT), as appropriate, begins in the CE phase as an integral part of the systems engineering process. Reference is made to the logistics performance requirements stated in the Operational Requirements Document (ORD). By Milestone I, a draft logistics plan is recommended to address the long-term deployment considerations. Deployment planning intensifies through the Program Definition and Risk Reduction phase so that by the Engineering and Manufacturing Development (EMD) phase, a

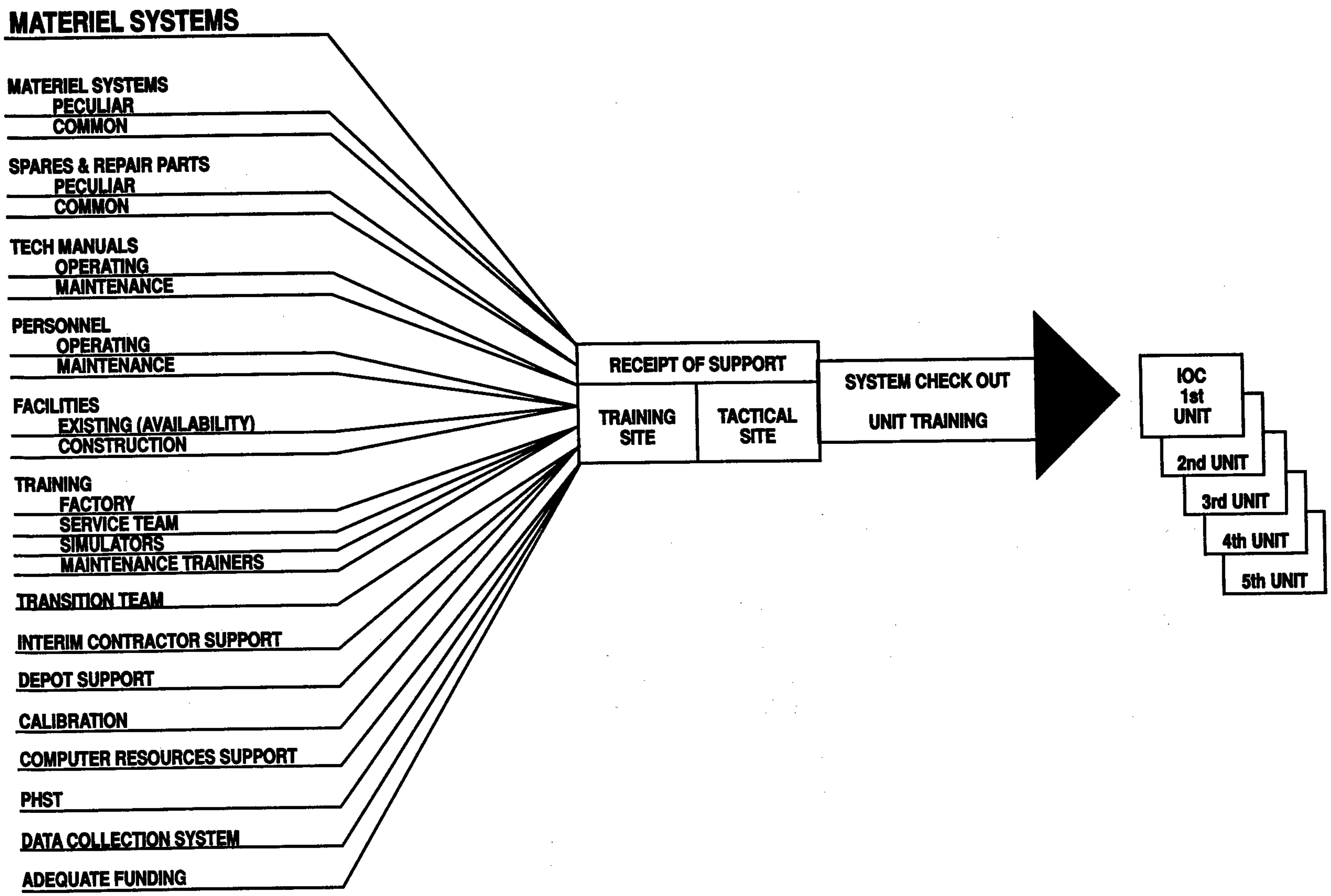

Figure 25-1: Deployment Requirements

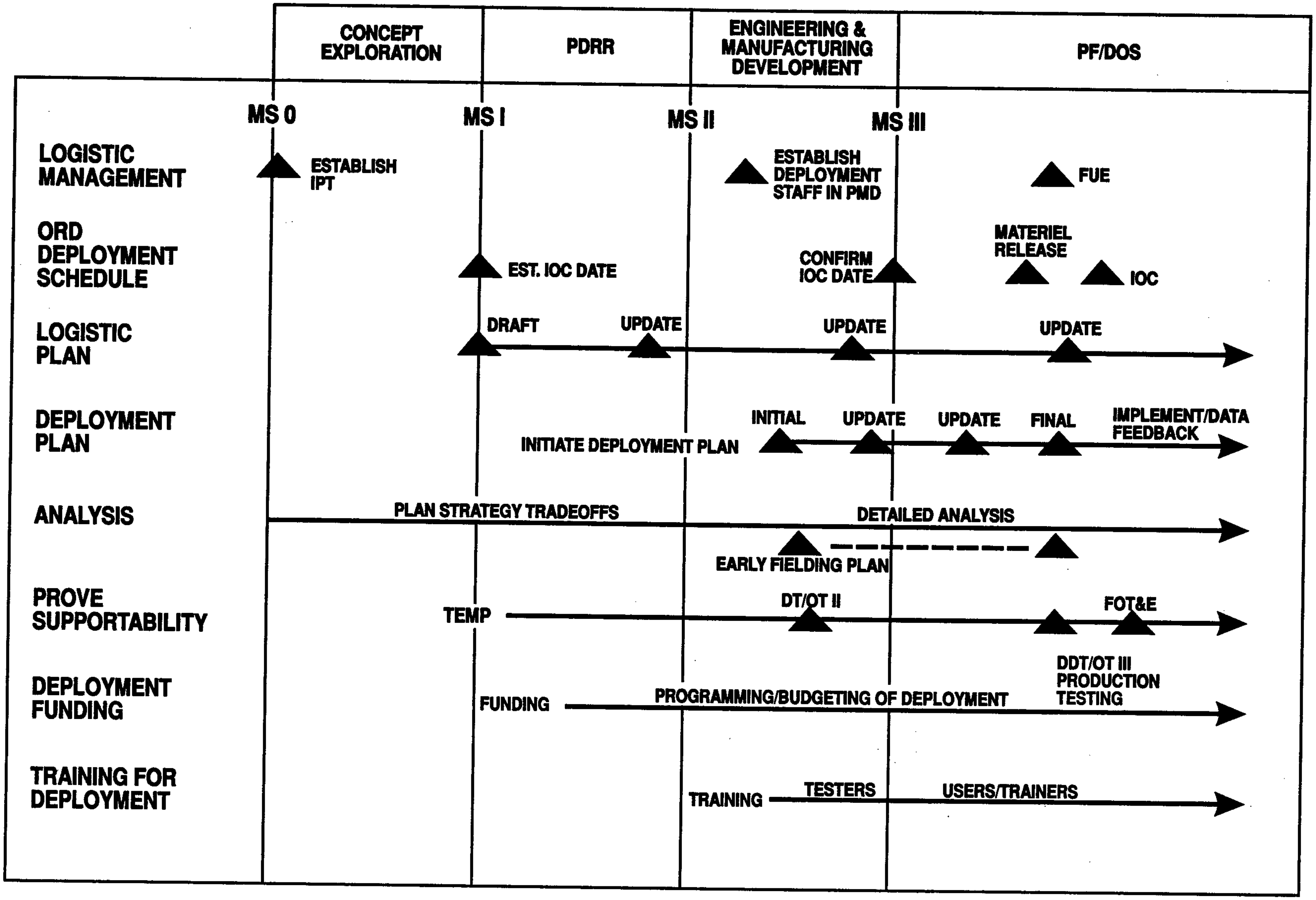

Figure 25-2: Deployment Activities

detailed plan for deployment can be prepared. This plan must be updated and coordinated on an ongoing basis to reflect program changes.

Dissemination of information to all participants and IPTs is very important; each change must be coordinated as needed and passed on to every organization involved in the deployment process. Figure 25-2 shows the relationship between deployment activities and major logistics activities. Changes in almost any aspect of the program (ranging from the very obvious, such as production schedule changes, to a less obvious change in unit manning requirements) can have an impact on deployment. Figure 25-3 provides suggested generic topics for inclusion in the plan. The logistics manager must be actively involved in deployment planning.

SYSTEM SUPPORT DETAILS
A. Limitation of data
B. Logistics support concept
C. Deployment agreement and certification (LOA, MOU)*

SYSTEM/END ITEM DESCRIPTION
A. Functional configuration
B. Organizational and operational concepts
C. Deployment schedules

LOGISTICS SUPPORT AND COMMAND AND CONTROL
A. Command and control procedures
B. Logistics assistance
C. Materiel defects
D. Coordination

SUPPORT REQUIRED FROM USING COMMAND

OTHER CONSIDERATIONS
A. Key correspondence
B. Plans and agreements
C. Developers checklist
D. User command checklist
E. Classified information

* Letters of agreement, memorandum of understanding

Figure 25-3: Typical Deployment Considerations

25.3.2.1 <u>Test and Evaluation</u>. Supportability of a system should be demonstrated before deployment. The logistics manager must ensure that the Test and Evaluation Master Plan (TEMP) includes supportability objectives, issues, and criteria. Development and opera-

tional testing during EMD provides information for the Milestone III production approval decision and provides input to follow-on testing requirements. These tests should provide assurance that the proposed logistics concepts and planned resources will be sufficient to support the system once deployed. This testing may also suggest changes to planned deployment actions. In addition, the Follow-On Test and Evaluation (FOT&E) may use the first unit equipped as the test unit; FOT&E planning must, therefore, be closely coordinated with deployment planning.

25.3.2.2 Logistics Plans. Contract performance specifications have an impact on deployment planning and execution. An early fielding analysis plan, in terms of desired performance, should be considered as a contractor task and an IPT action item during EMD. This plan should be revised as input data changes. Typical input data changes result from changes in deployment quantities and schedules and changes in manpower and personnel requirements or availability. Early fielding plans assist logistics management and the IPT by assessing desired performance in terms of many elements. Among the elements considered are the impact of the introduction of new systems on existing systems, the identification of sources of personnel to meet the requirements of the new systems, the impact of a program's failure to obtain all the logistics support resources, and the essential logistics support resource requirements for an operational environment. Early plans for fielding should consider addressing actions to alleviate potential fielding problems impacting performance i.e., risk analysis.

25.3.2.3 Funding. Specific funding requirements for deployment require early identification in terms of programming and budgeting. Deployment-related funding requirements may include military construction, training, travel, transportation of materiel, and contractor support; and they can involve both the program management office (PMO) and user funds. Program Managers (PMs) need clear visibility and control over such funds to accomplish deployment goals.

25.3.2.4 Warranties. The logistics manager must participate in the selection of essential performance requirements to be warranted in the production contract. Typically, warranties are on system or component reliability. The procedures for processing warranties should minimize impact on the user, particularly at the organizational level. Warranty provisions should enable the user to make warranty claims without delaying essential maintenance needed to restore system availability. Some years ago, the Navy established warranties that allow Navy personnel to perform needed maintenance and then recover the cost incurred from the contractor.

When a warranty is to be used, the user must be involved in the planning; and the warranty's impact must be accommodated in the deployment plan. The deployment plan should state which components are under warranty, by whom and for how long, the performance parameters covered, and the starting date or event of the warranty. It is often necessary to describe warranty provisions by equipment serial numbers. The interface between the user and the contractor should be explained in the plan.

Warranty coverage often begins when the item is accepted by the government and delivered to its first destination. If the first destination is a storage depot (despite DoD effort to reduce warehouse stocks) and the warranty period is measured in elapsed time, a portion or all of the warranted life may expire before the item is placed into use. Under these circumstances, it is preferable to seek warranty coverage that begins when the item is placed into service or coverage that is based upon a measure of usage such as miles driven or elapsed operating time. A more comprehensive discussion of warranties is contained in Chapter 19 of this Guide.

25.3.2.5 Management Information System (MIS). The logistics manager should establish a MIS to assist with the deployment planning and implementation processes. The number of logistics elements, the varied disciplines involved in planning for deployment, the numerous funding sources for support, and the multitude of interrelated data items make the deployment status difficult to track and update unless it is managed systematically. For example, a slippage in parts delivery for a simulator could mean that more training time is needed on the prime system. This would increase demands on maintenance (during a training period) and increase the demand for replenishment spares. The increased demand for spares could impact the availability of components for the production line or the initial support package for following deployments and, thus, cause a slippage in the deployment schedule. Slippage in the deployment schedule would increase the demand for support to the system being phased out – all the result of slippage in parts for the simulator. In addition, failure rates and operating problems could differ significantly from those encountered in the testing environment. These difficulties must be fed back to the logistics manager so the support deficiencies can be corrected. As a minimum, on-site data collection, reports of tradeoff analyses, status of support activities, and costs and funding reports should be included in the MIS.

25.3.3 Coordination and Negotiation

Establishment of a deployment IPT should be considered. The group should, at a minimum, have members from the using and supporting commands. Figure 25-4 depicts representative participants and responsibilities.

Deployment can involve negotiation of a major agreement, certification by the PM to deliver the system and its support, and certification by the user to prepare for its receipt. The agreement may be an integral part of the plan for deployment as it is negotiated between the two principals and coordinated among the many other participants and/or IPT members. Negotiations should commence before the production decision and should be documented as required by each Service. For example, in the case of the USAF, the turnover agreement in the past has been documented in the Air Force program management plan. The coordination may involve on-site meetings to coordinate the details of transfer, site planning and inspection, equipment on-site checkout, and similar activities. The initial units to receive a new system frequently compete for replacement spares with the ongoing production line and with the build-up to support subsequent deployments. Depot-level component repair may also compete with the production line for resources (test equipment, bits and pieces, skilled personnel, etc.). These problems are com-

pounded when the fielded reliability does not meet the planned reliability. The priorities established for satisfying requirements during this time of support and production build-up should be included in the agreement.

COMMAND/STAFF	RESPONSIBILITIES
Program Management Office	• Establishes working group • Develops supportability testing assessment • Provides input to training plans • Prepares deployment plan • Coordinates plan • Prepares deployment agreement or certification • Negotiates Agreement or Certification with Using Command(s)
User Commands	• Prepares operational support plan • Provides input to deployment plan • Negotiates agreement or certification with PMO
Test and Evaluation Organization	• Performs OT&E, FOT&E
Training Command	• Provides input to deployment plan • Prepares training plans and system training requirements
Service Staff	• Provides deployment allocations, personnel changes, training facilities and logistical inputs to the deployment plan • Reviews plans and agreements
Contractor	• Provides support warranty • May provide technical interim or life-cycle maintenance and supply support

Figure 25-4: Deployment General Responsibilities

25.3.4 Organization

As the planning for deployment intensifies, the PM should establish an organization or IPT within the PMO to assist the user, interact with the working groups, and resolve problems that arise during deployment. Deployment personnel should be considered for both PMO and on-site assignments. Teams or IPTs may be required for briefing and assisting user commanders and their staffs. System deployment teams on site can assist in the checkout of equipment, help perform the hand-off, train unit personnel, and assure that support capabilities are in place. The assistance of contractor personnel is often desirable at this time and should be considered in the planning.

25.3.5 Materiel Release Review

The release of the first system to each major user activity follows a period of extensive planning and coordination. The materiel release review (a formal Army activity that is applicable to all Services) is a control mechanism. It verifies that all materiel and logistics deficiencies identified in OT&E have been corrected and that all logistics resources required to support the initial deployment will be available concurrently with the release of the system. (See Figure 25-1.) The materiel release is, in essence, a certification by the developing activity that all conditions required to achieve initial readiness have been met.

25.3.6 Lessons Learned from Previous Deployments

Figure 25-5 summarizes problem areas associated with previous deployments/fieldings and suggested corrective actions. In addition, a comprehensive database called Automated Lessons Learned Capture and Retrieval System (ALLCARS), is the Air Force lessons-learned database. It is managed in the Aeronautical Systems Center by the Program Director for the Deskbook Joint Program Office (ASC/SYM) at Wright-Patterson AFB, OH. ALLCARS hosts lessons learned from the Combined Automated Lessons Learned (CALL) program. Contributing members are the Air Force, Navy, FAA, and NASA; each member is responsible for the content of their data.

ALLCARS seeks to close the gap between DoD organizations, U.S. Government agencies, and the defense industry by archiving and making available the documented experiences of customers and maintainers of government equipment. It is a central repository for unclassified lessons learned. If you have questions or comments, you may contact ALLCARS at:

Address: ASC/SYM, Bldg. 16
2275 D Street
WPAFB, OH 45433-7233

Phone: DSN 785-0423 or commercial 513-255-0423

COMMON PROBLEM AREAS	CORRECTIVE ACTIONS
Personnel Turnover	Document all plans, agreements, and changes. Conduct new equipment training close to the date that the unit will be equipped.
Conditional Materiel Release	User must understand and agree to the terms of a conditional materiel release.
Training of Operations and Maintenance Personnel	Software training is required before ATE delivery so the unit will be better prepared to participate in the acceptance testing. New equipment training must include provisions for the maintenance of equipment used in training. Contractor personnel may be considered for this task. Developer should brief operational commanders and their staffs periodically prior to deployment. Developer must ensure all required support equipment is available prior to new equipment training. Personnel should be scheduled for new equipment training. They should have the correct skills, sufficient time remaining in the unit, and meet all other training prerequisites. The use of videotapes and other media should be considered for new equipment training teams.
Establishing a PMO Deployment Team (Field Support)	Experienced fielding personnel who are logisticians familiar with the system are needed. Start looking for these people early.
Warranties	Establish simple procedures for returning failed parts to the manufacturer for analysis.
Deployment Plan for a Nonlogistics Significant Item	A plan may not be necessary, but the user must concur with the decision to eliminate the plan.
Contractor Involvement in Deployment Planning	Keep the contractors informed of requirements so they can assess their tasks. Contracts must be negotiated to ensure support items are delivered concurrently with the end item.
Hardware Problems During User Hand-off Period	Establish a staging area (may be at contractor's facility) where maintenance personnel can check out all equipment.

Figure 25-5: Common Deployment Problems

25.4 RISK MANAGEMENT

25.4.1 Funding Reduction

25.4.1.1 Risk Area. The risk area involves the reduced funding from the Acquisition Program Baseline (APB) values.

25.4.1.2 Risk Handling. Because cost is an independent variable, performance and schedule tradeoffs, in the final analysis, are all that is available other than program termination, to accommodate a reduction in planned funds other than program termination. The number of units procured (if more than one) can be thought of as either a performance or schedule issue. Risk handling requires that objective functions be conceived for various points on the time-line of the program. These functions should define how performance and/or schedule are related to cost, in order to help in the performance of tradeoff analyses. Such objective functions should be evaluated as to their validity and sensitivity tests performed. Only in this way can the PM be somewhat prepared for the increasingly severe financial future facing the Department of Defense.

25.4.2 Schedule Slippage

25.4.2.1 Risk Area. A risk area is the failure to understand how a schedule slippage in one functional element impacts the other elements and milestone events.

25.4.2.2 Risk Handling. The PM should employ a network schedule, such as the critical path method, which identifies all deployment activities and annotates the critical path of those activities that would delay deployment if not accomplished on schedule.

25.4.3 Delayed Facilities Planning

25.4.3.1 Risk Area. Failure to perform timely facility planning can result in substantial deployment delays.

25.4.3.2 Risk Handling. Facility requirements that are included in the military construction program normally have a planning and funding cycle of five years. In the case of NATO requirements, the cycle may run up to seven years. Early identification of requirements and coordination with the military construction proponent, therefore, is necessary, and a facilities support plan is desirable.

25.4.4 Updating the Deployment Plan.

25.4.4.1 Risk Area. Failure to keep the deployment plan updated, complete, and coordinated with all concerned can result in deployment delays and problems.

25.4.4.2 Risk Handling. As requirements, schedules, and responsibilities change, the fielding personnel in the PM's organization must be informed so they recognize the need

to promptly update the plan. In addition, the PM must also ensure that the plan and its changes are fully coordinated with the user and that the deployment IPT provides the vehicle for its coordination and distribution. Finally, the user should be required to prepare a plan for the receipt of the new system and should have established policy and procedures regarding the preparations for receipt of the new system by its subordinate units.

25.4.5 Managing Problems in the Deployment Process

25.4.5.1 Risk Area. Unreported and uncorrected deployment problems can seriously disrupt the process.

25.4.5.2 Risk Handling. Problems need to be quickly identified, reported, and solved. The deployment plan should provide a process that will lead to the rapid correction of deployment problems and deficiencies. On-site program management and contractor personnel can facilitate the identification and reporting of problems. In addition, for the benefit of future deployments, lessons-learned reports, based on the problems and their solutions, should be submitted to the appropriate Service agency.

25.5 SUMMARY

- Deployment is a key event in the acquisition life cycle. Its success can be evaluated in terms of how closely it adheres to schedule, how smoothly it is achieved, and how easily the user establishes the ability to meet and sustain the system readiness objective.

- The success of the process is directly related to how well it is planned, coordinated, negotiated, and executed. Major points are as follows:

  — Deployment planning, as part of logistics, is an integral part of the system engineering process and is initially addressed in the CE phase. Logistics performance requirements are documented in the ORD for Major Defense Acquisition Programs (MDAPs) and Major Automated Information Systems (MAIS) acquisition programs. Deployment planning intensifies during EMD; and it reaches a peak during Phase III as the deployment approaches.

  — Extensive coordination and negotiation characterize deployment. It deals with many long lead-time tasks, e.g., facilities, personnel, provisioning, procurement of training devices, and spares and repair parts.

25.6 REFERENCES

DoD Acquisition Logistics Handbook, MIL-HDBK-502, 30 May 1997, USAMC Logistics Support Activity, Redstone Arsenal, AL 35898-7466

26

READINESS AND SUSTAINMENT

There's never enough time to do logistics right, but there's always enough time to do it over . . . and over . . . and over.

Overheard in the PMO trenches

26.1 INTRODUCTION

The subjects addressed in this chapter pertain to a re-engineered logistics system and the future battlespace, and they express the philosophies of Dr. Paul G Kaminski, past Undersecretary of Defense for Acquisition and Technology (USD(A&R)). Many of the statements made are paraphrased from speeches made while he was serving as USD(A&R).

In view of the forecasts for shrinking future DoD appropriations, there is a pressing need to limit acquisition and support costs and to apply the concept of Cost As an Independent Variable (CAIV). The logistics slice of the defense budget is about 17 percent of the DoD top line each year; it is roughly equal to the amount spent on procurement or on research and development. These are the policies, realities, and resources that are available to provide a seamless logistics partnership for a force being designed to achieve dominant battlefield awareness and combat superiority. This is a force that emphasizes fully integrated intelligence systems, technologically superior weapons systems, and re-engineered logistics.

26.1.1 Terms

In the world of Acquisition Reform and new policy issues that drive DoD strategy and force planning, new and modified terms have evolved. Some of these terms impact logistics, some are logistics concepts, some shade the meaning of old logistics terms, some have ill-defined definitions that are still evolving, and several of them overlap. Most relate to the concept of a logistically ready force capable of sustaining its logistics capability within resource constraints. Thus, recognizing the inexactness of the effort, the following approximate definitions are offered for this chapter:

- Readiness. Readiness is a state of preparation (measured against a set of criteria) of forces or systems to meet a mission.

- Sustainment. Sustainment is an effort to ensure that a system continues to meet its required Reliability, Availability and Maintainability (RAM) parameters, considering policies such as CAIV.

- Focused logistics. Forced logistics is one of four operational concepts originated by the Chairman of the Joint Chief of Staff in his 1996 document, "Joint Vision 2010." The other three concepts are dominant maneuver, precision engagement, and full dimensional protection. Focused logistics is defined as the fusion of information, logistics, and transportation technologies to perform the following functions:
  - — provide rapid crisis response;
  - — track and shift assets even while en route; and
  - — deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations.

- Logistics partnership. This concept foresees a closer bond between the warfighter and the logistician, achieved in large measure by the three guiding principles of reduced logistics that include the:
  - — response time by means of a true total asset visibility program,
  - — footprint achieved by reducing support equipment and consumables through system design/redesign actions, and
  - — infrastructure achieved by reducing outdated systems, inefficient or excess organic logistics capability, and unnecessary logistics inventory.

- Lean logistics. This term was first used by the Air Force to describe the utilization of improved transportation, including commercial systems, to replace traditional caches of "just in case" inventory.

- Spares modernization. This effort is essentially the same as technology insertion described in Sections 28.5 and 28.6 of this Guide. It includes redesigning secondary items to improve system reliability and maintainability at the subsystem and component level and reducing system's life-cycle cost; all of these efforts bring a significant return on investment.

- Flexible sustainment. Closely related to and overlapping spares modernization, flexible sustainment seeks to reduce life-cycle costs through improving the:
  - — use of tradeoff analyses during initial design,
  - — reliability of current systems through re-design, and
  - — systems management process that will facilitate technology insertion.

26.2 DISCUSSION OF LOGISTICS PARTNERSHIP

26.2.1 Reduced Logistics Response Time

The opportunity exists today for DoD managers to refine the support system and achieve reduced logistics response times. They need to think in terms of substituting fast transportation and real time information for layered inventory in order to improve logistics response times. They need to aggressively substitute the ability to rapidly transport material for the very costly practice of maintaining layers of redundant material stockpiled around

the world "just in case" the warfighter needs it at some specific locale quickly. Today's "just in case" system has evolved over the years in response to a cumbersome acquisition system, which provided little or no in-transit asset visibility and lacked a fast and responsive transportation system. The DoD situation today mirrors the commercial logistics sector as it was in the 1950s.

Similar to the transportation issue, DoD managers must substitute valid real-time information regarding the complete status of all resources, i.e., personnel, weapons, equipment, and supplies, for the current practice of maintaining redundant capabilities. DoD must develop and deploy a true, total-asset visibility program.

Commanders and logisticians need to know the combat readiness status or state vector for each force element. This knowledge must include the logistics posture of friendly and enemy forces as well as having a prediction of the resupply needs of each force element. To complete the logistics picture, available support and the need for future support must be propagated from each force element in the field through the whole support system. This is the true definition of total asset visibility. A strong linkage exists between dominant battlefield cycle time and total asset visibility. Without the latter, the former is seriously degraded.

A major system integration effort is needed to implement this logistics concept. It was Dr. Kaminski's feeling that most of the enabling technologies have been developed. Some of the information technologies that could immediately be brought to bear include bar code tagging technology; RF (radio frequency) smart response tags; relational database systems; miniature global positioning system receivers and position reporting transmitters; satellite and fiber command and control communications links; and predictive planning tools.

26.2.2 Reduced Logistics Footprint

There is a tremendous leveraging effect associated with reducing the amount of support equipment and consumables that the warfighter must take in time of war. This is especially important in the early stages of a conflict when airlift resources are scarce and before a sealift bridge can be closed. On new systems, it means paying attention to life-cycle costs early in the design of a new system. The message here is that back end sustainment costs are receiving more up-front design attention. The F-22 program, for example, is committed to this approach. There is a sizable technology maturation effort under way on the F-22 program. Each technology effort must "buy its way onto the program" in terms of reducing life-cycle cost and program risk.

To support these investment decisions, there is a fairly well developed life-cycle cost model that includes estimates for operational and logistics elements like unit-level consumables, training, expendables, depot maintenance, and mission personnel. However, given the speed with which new systems are introduced to replace those already in the field, the Department simply cannot wait on the new system development process to solve

the logistics footprint problem. DoD must create the proper incentives to insert new technologies in legacy systems in order to improve their reliability, maintainability, and sustainability.

26.2.3 Reduced Logistics Infrastructure

Within the department, the warfighters have come to clearly realize that every logistics dollar expended on outdated systems, inefficient or excess organic capability, and unneeded inventory, is a dollar not available to build warfighting capability. There is little doubt that private sector logistics support can be substituted for DoD organic capabilities in many applications with greater effectiveness, less cost, and no added risk. In this regard, the Department must strike the proper balance between efficiency, effectiveness, and risk.

The Department has made substantial progress in reducing inventories at all levels. Critical to these projected inventory reductions are increased use of commercial support alternatives to meet the department's materiel requirements. For example, the Defense Logistics Agency has reduced its wholesale medical inventory by 60 percent — $380 million — since 1992 by using commercial distribution methods rather than DoD warehouses to distribute medical supplies. They also achieved the shorter response times that are available through local commercial distributors. Since more than $22 billion of the total DoD inventory, nearly 30 percent, is comprised of consumable items, such as medical supplies, these initiatives are obviously critical to the achievement of continuing inventory reductions. Pilot programs are not enough. The Department must proceed quickly but prudently to broadly apply the lessons learned in these pilot programs.

In the depot maintenance operations area, for example, evidence indicates that industry support can substitute for much of the traditional organic capabilities within the Department and perform these functions better, quicker, and cheaper. There are significant opportunities to save tax dollars and reduce government investment in the logistics infrastructure by increasing the use of these private sector capabilities. Being consistent with their readiness and cost-effectiveness objectives, the Department must also pursue the maximum amount of widespread private sector participation in disposal and distribution.

The time is past for testing the concept with pilot programs at the margin of the logistics infrastructure. The big payoffs of outsourcing and privatization are yet to be realized. To realize these payoffs, DoD managers must think more broadly of privatization and outsourcing. In particular, they must pay careful attention to incentives for implementing privatization and outsourcing initiatives. There are sufficient incentives at the top of the Department, but the incentives need to be pushed down. This occurs when organizations gain ownership by sharing the savings.

The Department is truly moving beyond adherence to the old conventional wisdom that dictated owning all support capabilities for the warfighter. The effectiveness and efficiency of outsourcing various logistics support functions has been selectively tested, and

the tests have been successful. Now the immediate challenge is to move forward with widespread deployment of similar outsourcing privatization efforts across a broad front.

26.3 SPARES MODERNIZATION

See paragraphs 27.5 and 27.6 of this Guide.

26.4 FLEXIBLE SUSTAINMENT

26.4.1 Definitions

The following definitions appear in the *DoD Flexible Sustainment Guide* of 23 January 1996:

- Life-Cycle Logistics (LCL). A means of using supportability and affordability tradeoffs during the system's engineering process, the LCL can optimize acquisition of logistics and operations and support (O&S) costs while providing the best support package for the operational forces. In addition to cost, other factors such as changing mission requirements, new technology, and component obsolescence, may affect the tradeoff process. Assessment of cost-effective life-cycle support tradeoffs should be accomplished throughout the life of the system.

- Flexible Sustainment (FS). FS is a decision-point-driven process to implement acquisition reform in an orderly manner and to optimize investment strategies for support. FS introduces two new sub-processes, reliability based logistics, and trigger based item management. In addition, other innovative support solutions, such as procurement of Form-Fit-Function Interface spares, performance warranties, and obsolescence assessment are presented as cost-effective life-cycle support alternatives.

- Reliability Based Logistics (RBL). RBL is a process that recognizes the importance of designing reliability into systems in order to reduce the fielded maintenance support infrastructure. Specifically, RBL addresses whether an item should be treated as a consumable or a repairable. Decisions must be made as to whether the item requires commercial versus organic repair. Also, the method of support must be determined as a function of cost-effectiveness, considering the item's reliability, technology cycle, and useful life.

- Trigger Based Item Management (TBIM). TBIM is a proactive approach to assess fielded systems trends and re-examine the support structure when "triggers" (such as a change in reliability or maintainability, technology, or diminishing resources) are detected. These triggers enable Integrated Product Teams (IPTs) to take appropriate action before a support issue becomes critical.

- Form-Fitness-Function Interface (F^3I). F^3I is a mechanism to link design, fabrication, and support capability. This capability can reside in the same organization, either government or contractor. Key product performance characteristics and product acceptance criteria are specified. However, there is flexibility to change the design while meeting performance requirements; and there is additional flexibility to change the manufacturing processes pertaining to the design. The end item performance must be verified to demonstrate that it is unaffected by the design and/or process change. These changes must consider total life-cycle cost impacts as part of the overall decision process. Again, prior customer approval of changes may or may not be required, depending on the demonstrated capability of the supplier. Technology insertion without the need for equipment modification can often be accomplished with commercial substitutes. (See Chapter 21, Section 21.1, of this Guide for definitions of a commercial item, a modified commercial item, and a nondevelopmental item.)

- Sustained Maintenance Planning (SMP). SMP is a process that encompasses continual review of established maintenance plans to ensure the most cost effective, safe maintenance is being performed on in-service support systems. System age, changes in material conditions, failure modes, and the operational environment are continually analyzed to ensure that safe, affordable readiness is maintained. Emphasis is placed on use of Reliability Centered Maintenance (RCM) as a continual life-cycle process to establish and adjust preventive maintenance requirements.

- Logistics Reliability. Logistics Reliability is a measure of an item's ability to operate without placing a demand on the logistics support structure for repair or adjustment. Logistics reliability recognizes the effects of placing demands on the logistics support structure without regard to effect on function or mission.

26.4.2 Discussion

FS involves spares or parts and includes the functions of item managers and System PMs. It can also be defined as:

- the use of performance-based specifications including
  - F^3I specifications and
  - nongovernment standards;

- the development of innovative, cost-effective life-cycle solutions;

- a logical decision-point-driven process; and

- the control of ownership cost by systematically improving reliability.

Flexible sustainment is accomplished by:

- comparison of organic and commercial support options,
- assessment of support trends,
- technology insertion, and
- up-front analysis of reliability parameters.

FS consists of two major processes. The first is RBL, which deals with both acquisition and postproduction support; the second process is TBIM, which applies to fielded systems. These two processes are interrelated and complement each other.

When properly executed, these two concepts can result in improvements in the efficiency of the acquisition process and offer a relative reduction in near-term and life-cycle support costs. Both processes encourage the program manager to use cost-effective tradeoffs by taking advantage of commercial industrial capabilities and practices and using organic capabilities where appropriate.

FS is a product of Acquisition Reform initiatives and can be traced back to an Air Force Materiel Command-chartered Performance Based Business Environment (PBBE) integrated product team. In addition to FS, this team addressed the supplier's past performance, rating systems, and key processes. Single-process facilities, training integration, and training systems were also reviewed. When employing FS, the increased use of these six PBBE areas is encouraged.

26.4.3 Reliability Based Logistics

The RBL portion of FS suggests that, if the reliability of a system exceeds the system life or technology cycle, the maintenance concept should not be based on a plan that includes an expensive organic infrastructure. Further, RBL emphasizes the importance of designing reliability into systems. Thus, RBL is an expansion of the systems engineering process as it applies to subsystems and/or components. Specifically, RBL addresses the consumable versus repairable; the commercial versus organic repair decisions; support as a function of an item's reliability; its technology cycle; and the useful life.

Reliability is particularly significant in RBL. Evolving high reliability components and subsystems favor more spare decisions vice repair decisions. Rapidly changing technologies lend themselves to commercial support; stable technologies may favor organic repair capability. As used here, the term repair, deals with what happens to an item after it is removed and replaced on the platform; however, testability, reparability, training, and skill proficiency are important factors influencing flexible sustainment. Organic removal and replacement at field level is not in the context of repair during this discussion.

The FS guide, referenced in Section 26.4.3 (Tools), presents a reliability based logistics decision tree. This decision tree can be employed during the systems engineering/acquisition logistics support processes. It is an expansion on the overall question of spares versus repair and the source for each. Decision points on the tree deal with the reliability and technology life cycle as applied to new and future systems, making RBL a new way of doing business.

Additionally, elements of the support system and design criteria, as well, must be analyzed; their sensitivities must be established. This, or any logic tree, must be capable of intensive sensitivity analysis in order to find break points for reliability and to drive design goals for major subsystems and components. Sensitivity analysis can identify life-cycle cost drivers early; thus, such costs can be minimized while attempting to minimize any degradation of system capabilities. Sensitivity analysis, which determines the life-cycle impacts on resource consumption and operational readiness, also identifies the cost and readiness drivers that must be dealt with during the conceptual phase.

RBL will capitalize on existing commercial capabilities by using contractor/government relationships and new contracting vehicles and language. Contractor and government teams must fully trust each other, adopting insight versus oversight as a fundamental management style. Contracts need to employ performance-based warranties where they make sense and truly reduce life-cycle cost to the government. The FS Guide provides examples of warranty and contractual techniques that should be considered and tailored to the specific needs of a program.

26.4.4 Trigger Based Item Management (TBIM)

TBIM, as an element of FS, is a philosophy that recognizes the existence of both mechanical and manual indicators, which are available to tell item managers when to take corrective action concerning parts. TBIM is a proactive approach to addressing problems of deficiencies associated with the management of military products. It uses predetermined "parts" or component "triggers" or trends as indicators of potential problems. These triggers act as prompts for the management team to take appropriate action prior to the situation becoming critical. The increased use of triggers early in the management process is a key to improved support posture without increasing costs. Triggers can include change in reliability, change in technology, or vanishing resources. The item manager should have a pre-planned process for corrective action when a trigger or trend it is required. In Subsection 26.4.2.1, the manager or item manager is offered three alternatives to use when problems approach. The decision will be driven by the long-term rewards of improved efficiency in the acquisition process and a reduction in both near-term and life-cycle cost.

26.4.2.1 Three Corrective Action Alternatives. One alternative for corrective action is the traditional Build-To-Print (BTP) option for parts. Secondly, a Modified Build-To-Print (MBTP) option allows flexibility for a capability supplier to incorporate improved manufacturing processes in producing the specified design for a component. The third option is that of F^3I replacement, where product requirements are conveyed to excellent

sources in strict performance terms. In this option the contractor is responsible for the design and manufacturing processes. (A source for a model for spares reprocurement is given in Section 26.4.5 below.)

26.4.5 Tools

A few of the supporting data systems, such as the Naval Aviation Logistics Data Analysis (NALDA), are listed as a source of possible "triggers" in Appendix J of the 23 January 1997 issue of the *DoD Flexible Sustainment Guide*. A working prototype of a spares reprocurement model (process and methodology) is available through the Air Forces' Warner Robins Air Logistics Center. The World Wide Web address is:

http://web-tech.robins.af.mil/~f3i/main.htm

26.4.4 POC/Reference

- Naval Air Systems Command, Maintenance Planning and Design Interface Department, Air 3.2.
- Assistant Deputy Under Secretary of Defense (Logistics) MPP&R.
- PBBE products, including:
  - *Program Risk Management Guide*
  - *Performance Based Contracting Guide*
  - *Performance Based Product Requirements Guide*
  - *Key Supplier Process Handbook*
  - *Vertical Contract Change Guide*
  - Contractor Performance Assessment Report (CPAR) Form and Instruction
  - *Performance Risk Assessment Group (PRAG) Guide*
  - Joint Service Guide Specification (JSGS) (8)
- Statutes:
  - 10 USC §2464. Core Logistics Functions
  - 10 USC §2466. Limitations of the Performance of Material
  - 10 USC §2469. Contracts to perform workloads previously performed by depot-level activities of DoD: Requirements of Competition
- Data System Sources (sample sources of possible "triggers"):
  - NALDA — Naval Aviation Logistics Data System
  - VAMOSC — Visibility And Maintenance Operation Support Cost
  - RISE — Recoverable Item Simulation Capability (DO41B)
  - PQDRS — Product Quality Deficiency Reporting System (GO21)
  - WMER — Wholesale Management and Efficiency Reporting System (DO35B)
  - STAMMIS — Standard Army Maintenance Management Information System

27

POSTPRODUCTION SUPPORT (PPS)

<u>Acquisition Strategy</u>: *"Each PM shall develop and document an Acquisition Strategy that shall serve as the roadmap for program execution from program initiation through Postproduction Support."*

<u>Industrial Capability</u>: *"Prior to production termination, Components shall take actions to ensure there will be adequate industrial capabilities and capacity to meet postproduction operational needs."*

DoD 5000.2-R

27.1 DISCUSSION

The terms just-in-time logistics and focused logistics, in concert with Flexible Sustainment (FS), describe the logistics support system (including postproduction support), which DoD is striving to attain by the year 2000. Focused logistics will be the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while en route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations. Just-in-time logistics connotes a sharp reduction in the warehousing of spare parts, combined with compensating responsiveness in the fabrication and transportation elements of the logistics system. The common thread among these three initiatives (just-in-time logistics, focused logistics, and FS) is the managerial challenge of maintaining readiness at a substantially lower cost than in the past, i.e., developing a better, more cost-effective way to provide logistics support.

The actual attainment of focused logistics, as well as many of the initiatives comprising just-in-time logistics, lays outside the purview of the individual acquisition program. However, the resulting macro logistics system will have a significant impact on the accomplishment of postproduction support.

27.2 BACKGROUND AND OBJECTIVE

The objective of operational and postproduction support planning is to maintain the system in a ready condition throughout its operational phase within Operations & Support (O&S) cost levels documented in Life-cycle Cost (LCC) estimates and acquisition program baselines. Accordingly, the developer/Program Manager (PM) of Major Defense Acquisition Programs (MDAPs) and Major Automated Information Systems (MAISs) are

directed by DoD 5000.2-R (which serves as a general model for other programs) to plan for postproduction support as part of the overall program acquisition strategy.

Postproduction support planning is a relatively new responsibility for PMs. Prior to early 1991, operational and postproduction support planning was often left to the readiness or commodity commands of each Service. Developers were most concerned with design, development, production, and deployment of new systems. However, senior operational commanders took issue with this process because of the support problems encountered in maintaining systems in mission-ready condition. Moreover, readiness/commodity commands discovered continuing problems in providing spares, repair parts, and technical data because data packages were often unsuitable for competitive procurement; sole-source vendors had gone out of business; or the long-lead time for production would not meet urgency requirements. Hence, the Services and DoD realized that the development process must embrace a true "cradle-to-grave" design approach.

Today, the PM is charged with the responsibility for postproduction planning. Some would argue that the PM has enough to do without the added burden of this effort. However, if we consider the U.S. marketplace as product consumers, what are our expectations of manufacturers in the way of postproduction support of appliances, video recorders, or even our automobile? When contemplating the purchase of desktop or laptop personal computers, are we concerned about warranty, technical support, or the addition or replacement of components? What about response time? These are indeed important issues to consider. A company that failed to meet our expectations would probably not do well in the marketplace, and it is no accident that manufacturers give significant consideration to such design requirements. The military user must also have a comparably high level of support and responsiveness to meet their readiness requirements and mission objectives.

27.3 METHODS

Planning for postproduction support begins in the Concept Exploration phase, with much of the detailed planning and execution starting in the Engineering and Manufacturing Development (EMD) phase, when components and manufacturers of components are selected. (See Figure 27-1.) Design can still be influenced to lessen or eliminate any potential postproduction support problems. Development will take place using performance specifications in lieu of the detailed specifications used in the past. Interface specifications will be designed to promote open system architecture, permitting flexibility in accomplishing future updates and technology insertion. This early planning and analysis is at the heart of reliability based logistics. The analysis effort should be performed by or under the direction of an appropriate Integrated Product Team (IPT), and the government members should perform any segments that are beyond the scope of the EMD/Production contracts. The impacts of the emerging focused logistics system and reliability based logistics efforts must be integrated into the support analysis, with the expectation that spares requirements will be favorably affected. Likewise, items that are single-source or those that the government cannot obtain data rights for, should be identified; and plans should be laid for

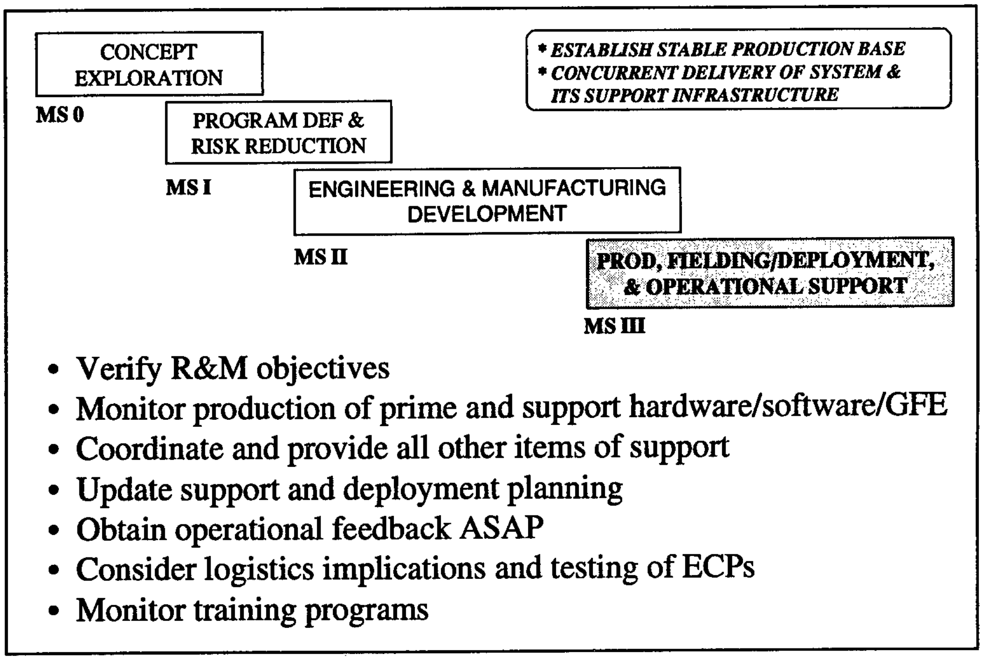

Figure 27-1: Time-Phased Support Activities

appropriate long-term support, e.g., organic support capability, production-line buy-out, or contractor logistics support agreements.

Despite the best planning efforts, support problems are certain to occur during the post-production period. The digital data stored in the Continuous Acquisition and Life-Cycle Support (CALS) system as well as other DoD Component-specific data systems will be important resources in analyzing support problems and developing appropriate corrective actions. Identified support problems, such as inadequate sources of supply or repair, should be analyzed to determine alternative solutions, the costs and associated risks involved, and an estimate of the funding and other actions required to implement preferred solutions.

Service lives of current systems have been extended for periods far beyond those originally planned. As a consequence, many suppliers are no longer in business or are unwilling to accept contracts for components that they originally produced in the distant past. Therefore, new sources will necessarily have to be brought on line through flexible manufacturing or other means. Some of the components thus affected can be replaced through the use of performance specifications, but others will likely require some detailed specifications to properly function in major systems designed in the earlier era of detailed specifications.

Opportunities to lower system life- cycle cost through technology insertion should be sought. In general, succeeding generations of technology offer both improved performance and improved supportability. Once identified, a potential candidate for technology

insertion should be recommended through appropriate channels for inclusion in the Reliability, Maintainability, and Supportability (RM&S) depot maintenance modification program.

27.4 TIMING AND ISSUES

Given the need to consider postproduction support issues, how and when does the PM accomplish postproduction support planning? First you need to understand typical issues, such as:

- increased parts usage,
- inadequate technical data,
- technological obsolescence,
- unacceptable LCC,
- lost vendor capability to provide spares/repair parts, and
- item deleted with no substitute.

Using a ten-year-old automobile as an example, what do you expect in the way of effective support regarding the examples above? Is it cost effective for manufacturers to make parts for a declining number of their products still in use? At what point should they halt production of spares? Will there be sufficient demand for manufactured parts? Are their original vendors still in business; and, if so, what was done with the tooling last used years ago?

Accordingly, if the need to conduct postproduction planning is accepted, how and when is it done? Planning is normally a government/contractor effort with a contractual requirement for the contractor to develop the postproduction support plan, which is subject to government coordination and approval. Such a plan normally is completed by Milestone III and updated periodically thereafter. The contractor does this effort as part of an overall supportability analysis structured to meet the PM's acquisition strategy of "cradle-to-grave" LCC and planning. Figure 27-2 provides a generic Postproduction Support (PPS) decision process.

27.5 DATA COLLECTION

Once a PPS plan has been created, it is important to have some way of measuring system readiness, which could trigger planned actions to provide effective support to the user. During O&S activities, the user implements a Unit Readiness Reporting system, which rates his organizational ability to meet assigned mission requirements. One part of this

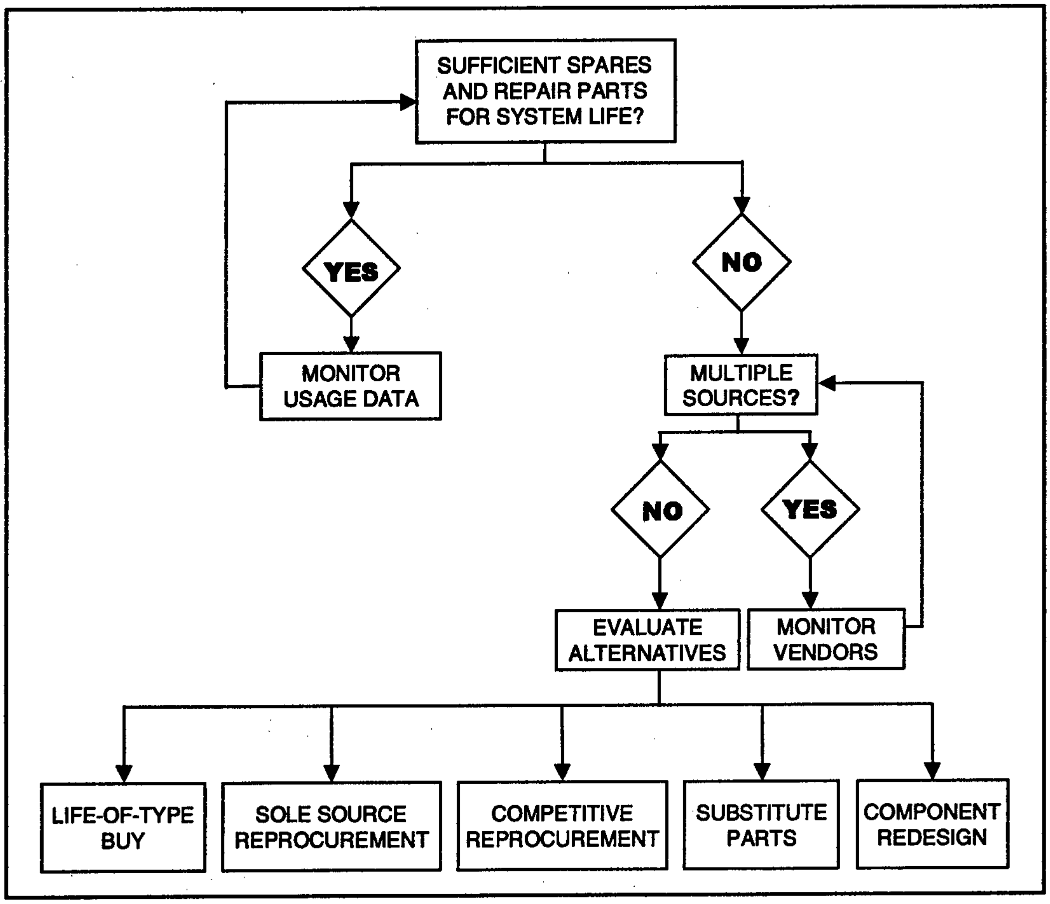

Figure 27-2: Postproduction Support Decision Process

report comments on materiel/system availability and offers reasons for non-mission ready systems. Another source of measuring system performance during the O&S phase is service maintenance data collection systems including:

- Army – the Army Maintenance Management System (TAMMS)
- Navy – maintenance and Materiel Management (3M)
- Air Force – Core Automated Maintenance System – Reliability Maintenance Information System (CAMS - REMISS)
- All Services – on-site contractor technical representatives.

This information and other sources will help us determine the specific cause of performance degradation. Examples are poor component reliability; aging systems; or, perhaps, improper fault identification. Current best practices include efforts identified as spares modernization, lean logistics, flexible sustainment, and other traditional sustainment remedies.

27.6 EXAMPLE

The Navy F-14A/B weapons system program provides an example of technology insertion as a part of postproduction support. The program office initiated a project to replace older mechanical gyroscopes with modern electronic ring-laser gyroscopes in each aircraft. The mechanical gyroscopes demonstrated an MTBF of 40 hours; and the ring-laser gyros demonstrated an MTBF of 4,500 hours, which was more than a 100-fold increase. A conservative analysis (which did not capture all of the cost benefits of the replacement) showed that the break-even point, i.e., when the savings repaid for the initial investment, occurred in the fifth year of operation. Substantial life-cycle support cost savings will accrue in the following years of service life planned for the F-14A/B weapons system. Of course, system readiness has improved from the very onset of the replacement program.

27.7 POSTPRODUCTION SUPPORT PLANNING

As previously noted, a postproduction support plan is normally undertaken as a joint government-contractor effort performed during EMD. It should be completed prior to Milestone III by an IPT and coordinated with other appropriate documents and the actions of other IPTs. The postproduction support plan should be maintained as long as the system is in the active inventory and should focus on issues such as:

- system and subsystem readiness objectives in the postproduction time frame
- organizational structures and responsibilities in the postproduction time frame
- modifications of planning documents to accommodate the needs of PPS planning
- resources and management actions required to meet PPS objectives
- assessment of the impact of technological change and obsolescence
- evaluation of alternative PPS strategies to accommodate production phase-out (second sourcing, standardization with existing hardware, engineering level of effort contracts in the postproduction time frame, life-of-type buys, contract logistics support versus organic support, maintenance concept change, suitable substitute, redesign, flexible computer integrated manufacturing)
- consideration of support if the life of the system is extended past the original forecast date
- data collection efforts in the early deployment phase to provide the feedback necessary to update logistics and support concepts
- potential for foreign military sales and its impact on the production run

- provisions for the use, disposition and storage of Government tools and contractor-developed factory test equipment, tools, and dies

Table 27A, at the end of this chapter lists additional issues that should be addressed in postproduction support planning.

27.8 ESTABLISHING A COMPETITIVE ENVIRONMENT

Relying on a single industrial source for critical support may increase risk in the cost and availability of spares and repair parts during the operational phase and, particularly, after termination of end-item production. The Logistics Manager (LM) should consider obtaining technical data, drawings, tooling, etc., to enable the Service to compete follow-on logistics support. The cost of obtaining this capability should be weighed against the potential benefits of competition, particularly during an extended postproduction period. Detailed component breakout plans, initially stated in the acquisition strategy and subsequently updated and refined, should be consulted. (Note: Historically, the government has not done a good job keeping configuration under control after the loss of production experience, equipment, and drawings; and it has purchased inadequate technical documentation to enable the breakout and competition of equipment, spares and, repair parts. Good documentation and configuration control is essential if the government is to successfully compete for follow-on support. It may be advisable to have the major manufacturer continue a level of effort in documentation after the production line closes).

27.9 POSTPRODUCTION SUPPORT DECISION MEETING

The PM should conduct a PPS decision meeting prior to the final production order to avoid major nonrecurring charges (if follow-on production is later required) and to update the PPSP based upon the latest data available. The meeting should also explore the advisability of purchasing items from the manufacturer; these items might include manufacturing structures, forgings and castings, insurance items to cover crash/battle damage or fatigue, proprietary data, and raw material.

27.9.1 Other Remedies

When faced with the imminent loss of production sources for unique spares and repair parts, there are two basic options available to LMs: they are to increase the supply or decrease the demand. A combination of actions listed in Figure 27-3 is often the most practical approach. These remedies are generally less effective and more costly than effective actions taken earlier in the production cycle.

27.10 FUNDING OF ENGINEERING AND PUBLICATIONS SUPPORT

There is generally a continuing need to correct hardware design, specifications, and software after the completion of system development. Changes to technical manuals are also

SPARE AND REPAIR PARTS ACTIONS	
INCREASE SUPPLY	**DECREASE DEMAND**
• Develop a reprocurement technical data package and alternate production sources. • Withdraw from disposal source. • Procure life-of-type buy. • Seek substitute (interchangeable) parts. • Redesign system to accept standard components if not interchangeable. • Purchase plant equipment; establish an organic depot capability. • Subsidize continuing manufacturing. • Draw (cannibalize) from marginal, low priority systems.	• Restrict the issue to critical applications in support of combat essential items. • Phase out less essential systems employing the same parts. • Restrict issue to system applications where no substitute is available. • Accelerate replacement of the system.

Figure 27-3: Logistics Actions to Reduce Impact of Loss of Production Sources

needed to reflect the system and software changes and to correct other deficiencies reported by operator and maintenance personnel. While the materiel system (end item) is still in production, the procurement appropriation bears the major burden of these costs. However, an abrupt change in funding responsibility occurs at the beginning of the first

Figure 27-4 is a notional display of the continued funding requirement for these costs extending into the O&S phase. While the total requirement for engineering and publication support should decrease as initial problems are detected and corrected, the total burden for such costs shifts to the Operation and Maintenance (O&M) appropriation after the termination of system production. Early recognition of the need for postproduction support and the programming and budgeting of O&M funds are required to maintain a continuity of effort. The increase in fund requirements shown in the late postproduction phase is attributed to growing design obsolescence and wearout. The LM should work directly with his supporting O&M appropriation manager to develop valid requirements estimates, which are usually derived from experience with similar systems, and the LM should program and budget accordingly.

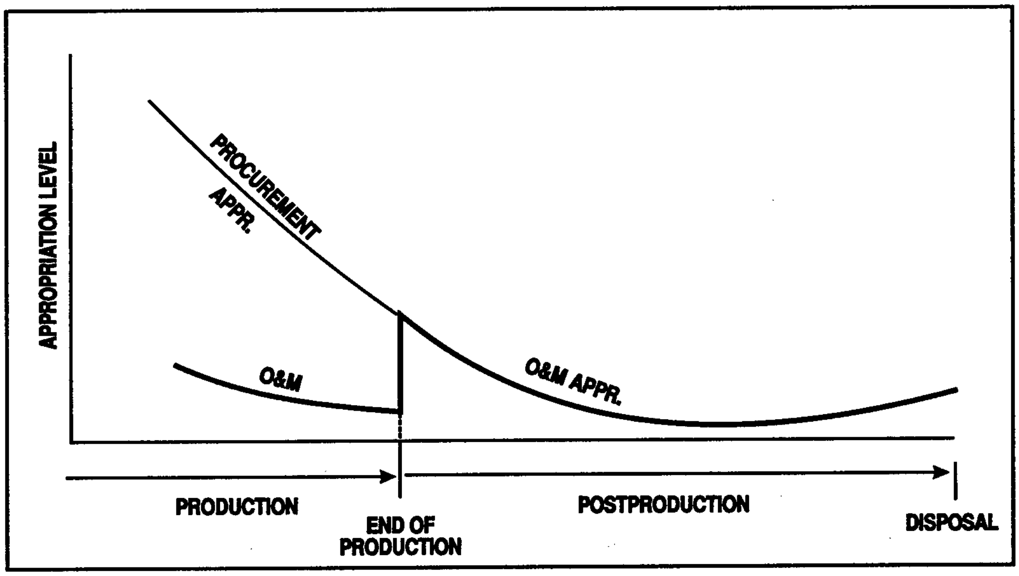

Figure 27-4: Sources of Engineering and Publication Funding

27.11 TIMELY PPS PLANNING

Postproduction support planning must be performed when acquisition strategy, design, and documentation options are still available for incorporation into an effective PPSP. To delay the planning invites the risk of having inadequate engineering and financial support for sustained system readiness and availability. The PPSP must be maintained and tied to each update of logistics plans. While such plans are essential to establishing the supportability and readiness of the materiel system, the PPSP is crucial to maintaining that supportability and readiness throughout the system's life.

27.12 SUMMARY

- The first empirical measure of system readiness occurs when the system is deployed in the operational phase.
- Readiness and R&M experience during the operational phase is employed to adjust the support resources that were programmed during the EMD and Production, Fielding/Deployment, and Operational Support phases.
- Performance and R&M deficiencies must be detected and corrected as early as possible in the O&S phase of the system.
- The objective of planning performed during system development is to ensure that readiness objectives are met and sustained through the O&S phase, including the postproduction period. Planning deferred until the problems are encountered will have limited effectiveness.

TABLE 27A
POSTPRODUCTION SUPPORT CHECKLIST

1. Supply Support

a. Continued producibility and availability of components and parts. (Peculiar items within the system should be reviewed down to the subcomponent level and national stock number.)

(1) Is technical data available at a reasonable cost?

(2) Is stability of design a concern?

(3) Is competitive procurement appropriate?

(4) Is the production base adequate?

(5) What proprietary rights, if any, have been declared by the prime or subcontractors?

(6) Are rights in data procurable at a reasonable cost?

(7) What is life-of-type buy potential?

(8) Are repair facilities available?

(9) Is the component critical to system performance?

(10) What is the expected life of the system/subsystem?

(11) Is there FMS support potential?

(12) Are workaround alternatives available?

(13) Are quality assurance requirements unique, difficult to duplicate?

(14) Is contract logistics support feasible?

(15) Will failure rates be high enough to sustain organic capability?

(16) Technology obsolescence. Is the system or part replaceable with new technology?

(17) Will potential design changes eliminate the need for the part?

(18) Is an engineering level-of-effort contract appropriate to ensure continued supportability?

b. What support equipment is required?

c. Will support of support equipment be available at a reasonable cost?

d. Is there an adequate organization to focus on and resolve postproduction problems?

TABLE 27A (Cont'd)
POSTPRODUCTION SUPPORT CHECKLIST

2. Engineering

a. Who has been designated to perform acceptance inspection QA on tech data?

b. Will there be adequate field engineering support, configuration management, and ECP support? Will there be adequate support to update:

(1) Technical manuals
(2) Production drawings
(3) Technical reports
(4) Logistics support data
(5) Operational and maintenance data
(6) User's manuals
(7) Data requirements

c. Will operational experience be considered in changes to the materiel system?

3. Competitive Procurement

a. Is production rate tooling complex/cost significant; is it readily available to procure, or a long lead item?

b. Are all cost factors associated with a breakout/competitive procurement decision considered? Cost elements should encompass added tooling, special test equipment, qualification testing, quality control considerations, rights in data procurement, etc. If performance specifications are applicable, the following additional costs pertain: cataloging, bin opening, item management, technical data, production and distribution variables, configuration control and engineering requirement costs, etc.

c. Are all potential customers included in the production requirements computations?

4. ATE Support

a. Hardware

(1) Will hardware be supportable?
(2) Will mission, ECP changes be compatible?
(3) Will modifications be possible, supportable?
(4) Is system expandable?

TABLE 2A (Cont'd)
POSTPRODUCTION SUPPORT CHECKLIST

b. Software

(1) Will diagnostic software changes be possible?
(2) Will the organizational structure allow for continuing software update?
(3) Will software changes caused by ECP/mission changes be incorporated?

5. Storage and Handling

a. Will shelf-life items be replaceable when they expire?

b. Will special shipping containers be replaceable/repairable?

c. Will peculiar manufacturing tools and dies be procured and stored?

6. Technical Data

a. Will manufacturing shop standards and procedures be retained?

b. Will all changes that occur during the production phase be incorporated in the manufacturing shop drawings?

7. Training

a. Will simulators and maintenance trainers be supportable in the out years?

b. Will follow-on factory training be required?

8. Maintenance

a. Will depot overhaul be required in the out-years? Organic — Contract.

b. Will provisions be made in the front end to accommodate a service life extension program if required? (Most recent materiel systems have been extended well past their original forecasted disposal date).

c. Will components be available to support the depot overhaul program in the out-years?

d. Is it realistic to co-mingle manufacturing with repair on a single production line?

28
TECHNOLOGY INSERTION/ MODIFICATION MANAGEMENT

> "In actuality, our military hardware is now on a replacement cycle of about 54 years – this in a world where technology typically has a half-life from two to ten years."
>
> "America's High Noon Complex"
> *Army RD&A Bulletin,* Sept-Oct 1994

28.1 POLICY

28.1.1 Open Systems Design

An open systems approach shall be followed for all system elements (mechanical, electrical, software, etc.) in developing systems. This approach is a business and engineering strategy. Specifications and standards are adopted by industry-standards bodies or de facto standards (set by the market place) for selected system interfaces (functional and physical), products, practices, and tools. Selected specifications are based on performance, cost, industry acceptance, long-term availability and supportability, and upgrade potential. For all Command, Control, Communications, Computers, and Intelligence (C^4I) systems; information systems; and weapons systems that must interface with C^4I systems or information systems, mandatory guidance is contained in the Technical Architecture Framework for Information Management (TAFIM).

28.1.2 Non-Traditional Acquisition

The DoD must be prepared to plan and execute a diverse variety of missions. To meet the user's needs in a timely manner, the acquisition system must be able to rapidly insert advanced technology directly into the warfighter's arsenal. The ability to rapidly insert technology demonstrates new and improved military capabilities on a scale adequate to establish operational utility and affordable cost. Demonstrations based on mature technologies may lead to more rapid fielding. Where appropriate, managers in the acquisition community shall make use of non-traditional acquisition techniques, such as Advanced Concept Technology Demonstrations (ACTDs), rapid prototyping, evolutionary and incremental acquisition, and flexible technology insertion.

28.2 DEFINITIONS

28.2.1 Open System

An open system is one that implements sufficient open specifications for interfaces, services, and supporting formats. It enables utilization of properly engineered components across a wide range of systems with minimal changes, interoperability with other components on local and remote systems, and interaction with users in a style that facilitates portability. An open system is characterized by the following:

- well-defined, widely used, and non-proprietary interfaces/protocols;
- use of standards, which are developed/adopted by industrially recognized standards bodies;
- definition of all aspects of system interfaces to facilitate new or additional systems capabilities for a wide range of applications; and
- explicit provision for expansion or upgrading through the incorporation of additional or higher performance elements with minimal impact on the system.

28.2.2 Standards-Based Architecture

Standards-based architecture is an architecture that is based on an acceptable set of standards governing the arrangement, interaction, and interdependence of the parts or elements. Together these elements may be used to form a weapons system that satisfies a specified set of requirements.

28.2.3 Open Systems Architecture (OSA)

The OSA is a system architecture that is produced by an open systems approach and that employs open systems specifications and standards to an appropriate level.

28.2.4 Open Systems Standards

Open systems standards are standards that control and fully define attributes for software, hardware, interface design, network protocol, circuit board design, etc. These standards have been developed and maintained in a commercial consortium or higher organization such as the ISO or IEEE group consensus process. Standards have requirements for compatibility and interoperability at the interface, but they do not define the performance of a given product. A commercial manufacturer may change the performance of a product without government knowledge and still comply with the standard. (Consent is not required since the government is now only another customer.)

28.2.5 Cost Definitions

- Operation and Support (O&S) Costs. O&S cost is the sum of the system operations and maintenance (O&M) budget appropriation; the military personnel (MILPERS) appropriation; and a small amount of costs in other appropriations, e.g., military housing maintenance.

- Direct O&M Costs. Direct O&M costs comprise fuel, depot maintenance, depot-level repairs (DLRs), interim contractor support (ICS), contractor logistics support (CLS), consumables, and similar expenditures.

- Indirect O&M Costs. Indirect O&M costs comprise base operations support (BOS), medical support, individual training, Permanent Change of Station (PCS) moves, communications, administration, and related expenditures.

- System Life Cycle. System life cycle is defined as the time from Milestone (MS) I to disposal. It includes all phases of the system's life.

- Service Life. Service life is the total system usefulness from first inception to final phaseout.

- Age. Age is the measure, at any given point, of the elapsed time since a system completed production. (Average age can be calculated for an entire fleet.)

28.3 BACKGROUND

For a number of years, the U.S. military budget has been shrinking rather markedly; and the portion of the budget available for new weapons system procurement has shrunk the greatest. O&S costs have been more resistant to near-term shrinkage. In 1996, the Commandant of the Marine Corps stated that the Marine's workhorse Sea Knight helicopters would be 50 years old before they are replaced in 2017. In 1994, the Air Force Scientific Advisory Board projected the following aircraft equipment age at retirement. These projections are based on current trends and foreseeable appropriation levels:

AIRCRAFT TYPE	NUMBER OF AIRCRAFT	AVERAGE AGE NOW, years	PROJECTED RETIREMENT	AGE AT RETIREMENT, years
C/KC-135	638	33	2040	79
B-52	94	34	2030	70
C-5A	77	25	2021	52
C-141	248	29	2010	45
C-130 (20 yrs and older)	439	30	2030	66
F-15	940	12	2020	38
F-16	1727	7	2020	33

The same age trends apply to virtually all Army, Navy, and Air Force weapons systems. Thus, there is a pressing need to find ways to decrease the operating costs of the current weapons systems and increase subsystem capabilities (including reliability and maintainability) through technology insertion.

The insertion of technology improvements before, after, or during the production phase is accomplished whenever feasible to enhance system capability, reliability, or both. The key facilitator to technology insertion is open systems architecture. The following discussion focuses on the logistics aspects of technology insertion and, hence, on cost-saving and/or reliability-enhancing initiatives.

28.4 OPEN SYSTEMS DESIGN: A PREREQUISITE

An open systems approach for systems provides a foundation for lower life-cycle costs and improved systems performance through use of standards-based architectures and greater access to commercial technology, products, and processes. A framework for open systems implementation is achieved by addressing the key considerations of interfaces, architecture, risks, and supportability.

28.4.1 Interface Management

Interface management is an important element to open systems design. A process should be used to select interface standards, which employ minimal criteria (openness, maturity, performance, conformance, and future needs) in making the standards selection. Typical guidelines for choosing interface standards are:

- hardware and software interfaces identified;
- interface standards based upon open specification and standards, where practical;
- proprietary and unique system interfaces identified;
- minimal use of options or extensions to interface standards;
- supportability, upgrade, or technology insertion plans considered in standards selection;
- market analysis of commercial items or nondevelopmental items interface standards used;
- assessment of customers using the selected interface(s);
- assessment of suppliers providing products compliant with the interface(s) selected; and

- compliance assessment of interfaces to the TAFIM whenever the system interfaces with command, control, communication, computer, intelligence, surveillance, and reconnaissance (C^4ISR) systems.

28.4.2 Architecture

An architecture identifies components, the relationship among components, and the rules for the architecture's composition. An open system approach is based on an architecture that uses open standards to describe these relationships and rules. Typical guidelines for addressing architecture are:

- Define and describe a system architecture that is traceable to the Operational Requirements Document (ORD).

- A preferred architecture is modular, hierarchical, layered, and based on open standards at its interfaces.

- Selection of an architecture should be a cooperative process between government and industry.

- Specify key performance attributes of system building blocks including internal interface standards where necessary.

- Where a new system is contemplated, consensus among potential contractors and their key suppliers on application of widely accepted standards is desirable.

- Identify aspects of the program that might limit the use of an open systems approach.

- Determine the level at which the architecture will be defined for the system.

- The architecture approach resulting from a system engineering process should be linked to a business case analysis.

- Decisions about architecture should be linked to performance, life-cycle cost, schedule, and risk.

- Identify opportunities for reuse of hardware and software configuration items and dependence upon interfaces.

28.4.3 Associated Risks

An open systems approach should facilitate the management of risks associated with the use of commercial items or nondevelopmental items. Although the open systems ap-

proach, through the use of open specifications and standards, serves to mitigate risks, it also carries its own unique risks. The risks associated with products implementing open systems may be varied; but potential issues, such as product availability, supportability, standards conformance, and configuration control, may need to be addressed. The following are guidelines for consideration:

- Identify the risk(s) to the program as a result of implementing open systems.
- Determine the risk mitigation approach for handling the risk(s).
- Determine which hardware and software areas present potential risks when using open systems.
- Determine which hardware and software will be reused and which impede open systems.
- Establish contract incentives to facilitate the open systems approach.
- Establish a teaming arrangement that is conducive to implementing impartial interfaces.
- Establish a process supported by a "make or buy" plan for choosing between the development or purchase of end items within the system.
- Assure that the contract imposes necessary system interfaces including those for legacy systems interoperability and interchangeability and open system interfaces for new technology.

28.4.4 Supportability

The use of open standards-based commercial items or nondevelopmental items brings a host of new support considerations. Baselines will continue to migrate because industry releases new products in a shorter time frame than is customary in the traditional DoD systems acquisition process. With inexpensive product availability and the ease of insertion that is facilitated by the employment of open standards-based products, the maintenance approach for an open system changes dramatically.

- Support planning and execution should consider how an open system environment would be accommodated.
- Support drivers (product uniqueness, spares, redundancy, graceful degradation, fault detection and isolation, and design stability) that influence the maintenance philosophy and the interdependencies with open system implementation should be examined.

- Assess the change in maintenance approach via upgrade verses traditional repair and reuse.

- Assess the support infrastructure ability to accomplish technology insertion in lieu of traditional repair and reuse.

- Re-assess the technological currency of the products supporting the system's logical, functional, and physical interfaces. Also re-assess the associated standards upon which the products are based and develop a risk mitigation and technology migration plan to accommodate system obsolescence, upgrade changes, and technology enhancements.

28.5 TECHNOLOGY INSERTION DURING THE DEVELOPMENT AND PRODUCTION PHASES

The rapid pace of technological improvement in today's commercial market demands that the program IPTs (e.g., design/support IPTs) search for opportunities to enhance the supportability and reliability characteristics throughout the development process. As new opportunities are brought to light, the IPTs should oversee a cost-benefit analysis of each candidate item to assist the PM in his decision and timing regarding the insertion. The funding of a technology insertion is a challenge at any stage in the weapons system development cycle; but it is generally simpler in the development or production phases, where RDT&E and production funds are available, than it is in the phases subsequent to production.

28.6 POSTPRODUCTION TECHNOLOGY INSERTION

28.6.1 Identification of System O&S Cost Drivers

Each of the Services has automated methods in place to characterize O&S costs. These include the various Service-specific Visibility and Management of Operation and Support Cost (VAMOSC) implementations as well as other systems. However, no Service is capturing actual costs by system. Typically, the Services capture maintenance rates and supply demand rates, compute system O&S costs using standard labor hour and supply prices, and allocate costs by system. These processes are error-prone, subject to data losses (such as lost computer tapes), and also subject to erroneous input factors.

Despite such limitations, existing automated cost systems are good enough to support system-specific O&S cost reduction efforts. The reason is that, for purposes of determining O&S-related opportunities for technology insertion (e.g., reliability improvement), the methods are generally adequate. Although the systems cannot accurately determine absolute costs, they can establish relative costs; and this capability is what is needed to identify, in turn, the cost drivers. It is the cost drivers that are prime targets of opportunity.

28.6.2 Prerequisites for Technology Insertion to Reduce O&S Costs

Three fundamental factors must be in place to use technology to reduce O&S costs:

- The technology itself must be available. It must be developed and proven sufficiently to be adapted to specific systems, and it must provide a cost reduction opportunity. Application could be either to the weapon support infrastructure or to the embedded subsystem or component of a system itself.

- There must be sufficient resolve to use the technology and dedicate resources to that end. Typically a technology insertion for purposes of cost reduction involves an initial expense justified by a cost-benefit analysis that demonstrates a cost reduction in the long run. To qualify, the Services generally require the cost-benefit ratio to exceed a specified threshold value within a prescribed time period.

- There must be opportunity to apply technology. The life cycle of a weapons system presents three basic windows of opportunity: during the development phase of system acquisition, during a major modification of the weapons system, or during insertion in in-service weapons systems (the principle focus of this chapter).

Funding has been the sticking point in the past for cost-saving technology insertion. Candidate cost-saving projects tend to compete for limited funds with numerous other programs/modifications that promise increased operational capability. Repeatedly the cost-saving candidates are ranked too low to be funded, particularly in the postproduction phase. However, with the advent of the Cost as an Independent Variable (CAIV) direction, life-cycle cost is a driving program management consideration; and the PM and the entire acquisition system are more closely attuned to cost-saving opportunities. In addition, concerted efforts are underway at OSD and Service levels to develop funding strategies that will assist the PM's efforts to insert new technology and, thereby, enhance reliability or otherwise reduce life cycle cost.

28.6.3 The Defense Working Capital Fund (DWCF)

The DWCF (formerly known as the Defense Business Operating Fund is a potential source for financing cost-saving technology insertion candidates. A description of the "DWCF is presented in the following paragraphs. The reference source is the "DWCF Handbook," CALIBRE Systems, Incorporated, Falls Church, Virginia, and the Office of the Under Secretary of Defense (Comptroller), Washington, DC, 1995.

As a revolving-fund financial structure, the DWCF builds on revolving-fund principles, which were previously used for industrial and commercial-type operations. The DWCF consists of multiple divisions identified by Component and by business area. Within these business areas, there are support organizations (providers) operating like commer-

cial businesses by selling goods and services to DoD's operating forces and other business areas (customers).

Customer orders (funded requests for goods and services) provide the budgetary resources to finance defense business operations. Customers fund their requests primarily with appropriated resources, e.g., operation and maintenance; procurement; and research, development, test and evaluation. Income (or budgetary resources), which is derived from the sale of goods and services, is then used to finance the DWCF business areas' continuing operations without fiscal year limitations. Unlike profit-oriented commercial businesses, DWCF businesses strive to break even in prices charged to customers. Revenue from customers sustains the full cost and the continuous cycle of DWCF business operations.

The basic tenet of the DWCF financial structure is to create a customer-provider relationship between military operating forces and support organizations.

- Customers of the DWCF business area providers include any DoD command, organization, non-DoD Federal Government Agencies, and other U.S. and foreign agencies and commercial enterprises when authorized by DoD.

- Providers in the DWCF customer/provider relationship are the business areas and related support organizations that are responsible for providing goods and services to the operating forces and that are financed through the DWCF.

The customer/provider relationship is fundamental to the DWCF financial structure. The relationship has significantly increased the customer's responsibility for properly determining support requirements and the level of performance required from DWCF financed support organizations. The result of the customer/provider relationship is a meaningful linkage between military mission operations and the cost to support those operations.

This linkage is a major feature of the DWCF's control process. The inclusion of previously directly financed areas in the DWCF is causing the DWCF business area operations to be financially sized (in both budget and implementation). This "sizing" is based on their customers' requirements and appropriated resources available for DWCF goods and services. In other words, the resources required by the DWCF business area organizations to continue operations vary directly with their customers' needs for their goods and services. As the volume of customer requirements decline, the relative financing of a supporting DWCF business area will, too. The significance of this linkage makes it essential for customers and providers, alike, to understand the nature of the DWCF financial processes and the potential impact they can have on military readiness.

In summary, the DWCF financial structure and management process focus on total cost visibility and full cost recovery for DoD's support functions. The DWCF financial structure provides DoD managers with improved financial management tools and facilitates the reduction of DoD support costs through better business practices. The use of the DWCF financial structure is intended to:

- foster a business-like customer/provider approach that enables the customer to make economical buying decisions and encourage the provider to become more cost conscious;

- identify the full costs of support, measure performance on the basis of cost/output goals, and foster efficiency and productivity improvements;

- provide timely and accurate information to decision makers at all levels to enhance the decision-making process; and

- more closely relate the support infrastructure with the force structure.

28.6.4 Alternative Funding Sources

Generally, a potential candidate for cost-saving technology insertion on in-service systems (infrastructure or embedded) must be able to project a payback within five years to defray the front-end startup costs and further attain savings in the out years during the remainder of the service life. There are three general ways to finance the front-end costs of a cost-saving technology insertion opportunity; these three ways utilize: (1) appropriated funds, (2) the Defense Working Capital Fund (DWCF), or (3) DWCF funds combined with appropriated start-up funds.

28.6.4.1 <u>Appropriated Funds</u>. Either the military Services or OSD could budget appropriated funds. Historically, Service attempts to budget funds for cost-reduction have not worked well. Cost-reduction projects typically rank below the prioritization cut-off line and, thus, are not funded.

28.6.4.2 <u>DWCF Financing</u>. A potentially attractive alternative to appropriated funding is DWCF funding. Three DWCF approaches should be considered in the following circumstances:

1) The funds needed to finance cost-reduction modifications could simply be included in the DWCF operations budgets. This approach has the advantage of recovering the investment immediately. However, it also affects user prices in the year of investment, forcing them to pay up front for an investment that will produce savings later. Users understandably are not enthusiastic about this approach.

2) It is possible to request direct appropriations for insertion into the DWCF components (Army, Navy, and Air Force). The problems with this approach are that the investment is not necessarily recovered (there is no obvious mechanism to do so) and that the approach amounts to a pass-through of appropriated funds. Hence, it adds little or no value while placing DWCF administrative procedures on top of appropriated procedures.

3) By using the DWCF capital budgets, the investment could be recovered. Additionally, from the operational user's point of view, amortizing the investment over the period of expected benefits would match the cost and benefit streams in time. It is this approach that is recommended in most cases.

To implement the DWCF capital budget approach, it is still necessary to provide up-front funding until the program is self-financing. This funding could come form two sources: (1) DWCF cash can be used, assuming cash is available; and (2) an initial appropriated input can be used. The latter is the case for Program Budget Decision (PBD) Number 714 of 29 January 1996. A copy of that PBD is attached at the end of this chapter. A substantial investment will be needed for some time until the program becomes self-financing. The investment required depends on the magnitude of benefits desired. The period until the program becomes self-financing will depend on both the actual rate of return and the amortization schedule.

28.6.5 Service Potential for Technology Insertion

In a recent study conducted by the Logistics Management Institute (LMI), each Service was contacted to propose promising candidate components or subsystems for which the technology exists to allow substitution of technically superior items to improve overall system reliability and maintainability. A significant number of candidates were identified. For each candidate, the required initial investment was calculated, and then the potential return on investment (ROI) was calculated assuming a service life of 10 years or more following the modification, at which time the savings would theoretically end. (ROI is the savings in operating costs over a defined period divided by the front-end investment.) The study concluded that for a sustained program, an ROI of 9:1 could be achieved, with the greatest potential return available from those items that focus on improved reliability (as opposed to maintainability).

The Army and the Navy depend on industry sources to bring forth cost-saving ECPs at their own expense. As a result, candidate items generally have been limited to those cases where the benefits are so dramatic that the initiators have high confidence that the ECP will be approved. The result has been a paucity of Army and Navy candidate projects in the past. Candidate Army projects that do emerge are produced, for example, by the Army Tank Automotive and Armaments Command (TACOM), which is under a Technology Insertion-Operation and Support Cost Reduction (TI-OSCR) program and is funded under DWCF. The Navy considers similar projects under the BOSS-III program, which is project-by-project funded under DWCF. The Air Force PRAM program is, also, typically accomplished with DWCF funding after the engineering development.

28.6.6 Examples of Postproduction Technology Insertion

The Air Force is currently in the lead in this regard. They have a Technology Transition Office and a budget line item (RDT&E) to perform the front-end engineering to identify candidate projects and develop appropriate engineering change proposals (ECPs), either in-house or under contract. They have developed at least 19 specific subprojects, with funding of about $220 million annually (RDT&E funds). One of these, the Producibility, Reliability, and Maintainability (PRAM) project, is level-of-effort funded at $20 million annually. Overall, PRAM has produced a return on engineering investment of about 5:1.

Cost-reduction opportunities exist through insertion of technology into the infrastructure as well as into the weapons systems themselves. An example involving the support infrastructure is the replacement of standard hard-copy technical manuals with Interactive Electronic Technical Manuals (IETMs). A demonstration test, which the Air Force ran on the F-16 aircraft, documented a reduction in diagnostic time of 40 percent. In addition, the test demonstrated a large increase in the diagnostic success rate, which approached 100 percent. Both factors are important to cost. But the diagnostic success rate is particularly important because it influences retest-OK rates; and they, in turn, influence spares pipeline requirements.

An embedded cost-reduction opportunity was pursued in the case of the C-17 aircraft during the development cycle. The TF33 engine powered the C-141 predecessor aircraft. The C-117 engine developed for the C-17 aircraft has a fuel consumption rate of approximately 60 percent of the TF33 engine, and fuel costs are a major part of the cost-of-ownership of an aircraft. Thus, the cost avoidance over the 30-year or greater life cycle of the aircraft will be very great. In addition, the C-117 engine is roughly five times as reliable as the TF33 due, in large part, to a set of demanding reliability and maintainability performance requirements laid down in the Operational Requirements Document (ORD) at the onset of the system development.

Another cost-reduction opportunity was accomplished on the in-service F-14 aircraft fleet. The original mechanical gyroscopes on the aircraft were replaced by a new-technology, the Embedded GPS Inertial (EGI) system. The new inertial system is demonstrating a 100-fold improvement in reliability – from 40 hours MTBF for the mechanical gyro to 4,500 hours for the EGI system.

The Army's 5-ton trucks are 6-wheel-drive vehicles. They were designed with universal joints on the front axles. Due to the geometry involved, U-joints cause a sinusoidal variation in tire rotation speed when the vehicle is turning. This design causes accelerated tire wear during turns. The automobile industry has designed front-wheel-drive cars with constant velocity (CV) joints to overcome this effect. The Tank and Automotive Command has introduced a program to replace both U-joints with form-and fit-compatible CV joints whenever one of the U-joints fails. The savings in this case are in longer tire life. The program achieves rapid savings, with the break-even point occurring in about two years.

28.7 MODIFICATION MANAGEMENT

The starting point in change preparation is recognition of a deficiency and the decision to employ a design solution. The request to change production, and possibly retrofit fielded equipment, may be originated by the government or the contractor. One approach is preparation of an Engineering Change Proposal (ECP). Numerous contractor and government actions are involved in the process of responding to a deficiency with an ECP. An example of the actions involved from the preparation of an ECP by a contractor and the subsequent change implementation by the government is shown in Figure 28-1.

The Logistics Managers (LMs) must be actively involved in:

- determining the impact of the ECP on each logistics element;
- developing requirements and schedules for required changes to affected logistics elements;
- participating in engineering review board and change review board meetings;
- ensuring that associated changes for related support equipment and training devices are available for concurrent review and approval;
- ensuring lead times for changes to logistics elements are compatible with the planned implementation of the ECP on the production line; and
- ensuring that changes to logistics elements are funded.

28.7.1 Change Implementation

After government approval, the contractor initiates action to finalize the change for production and/or retrofit concurrently to modify the affected logistics elements. The government accepts the modified systems. The government LM is normally responsible for the application of retrofit kits and must assure that the required changes to the logistics support of fielded systems are applied or are available concurrently with the application of retrofit kits to the systems. Grouping retrofit kits into block modifications and applying them to complete production lots can facilitate this latter requirement.

28.7.2 Management Information System

A management information system (to include logistics elements) is an essential component of configuration status accounting. It is employed to manage changes of logistics resources and to maintain concurrent compatibility with changes to the system.

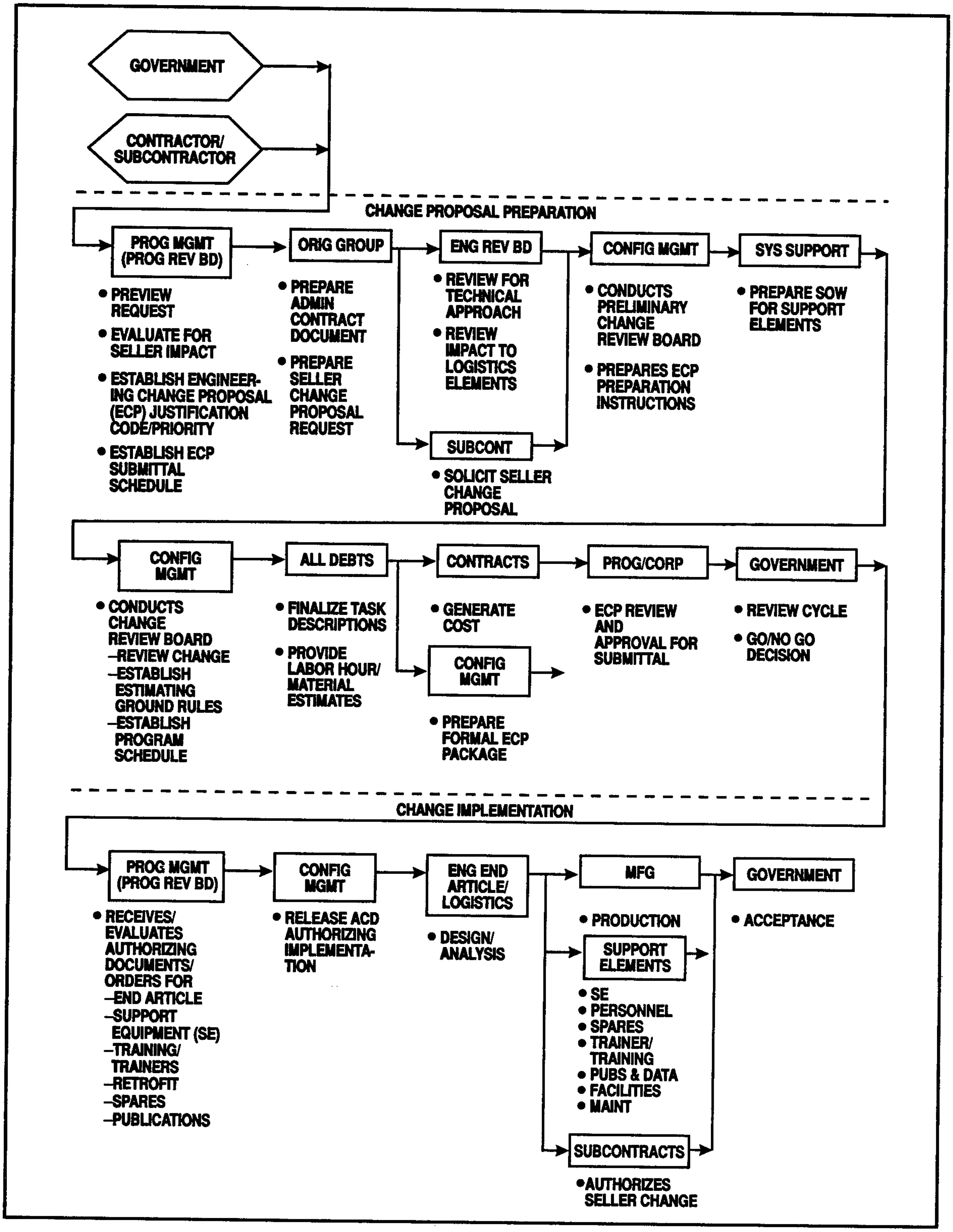

Figure 28-1: One Variation of ECP Preparation and Implementation by a System Contractor

ATTACHMENT A TO CHAPTER 28

A CLOSE FACSIMILE TO PROGRAM BUDGET DECISION

NUMBER 714,

FISCAL YEAR 1997

Attachment A is presented for teaching purposes only.

FOR OFFICIAL USE ONLY

PROGRAM BUDGET DECISION No. 714

SUBJECT: Depot Maintenance Reliability Program

DOD COMPONENTS: Army, Navy, Air Force

	FY 1996	FY 1997
Service Estimate		
OA, $ Millions	-	-
Civilian End Strength	-	-
Civilian Fees	-	-
Alternative Estimate		
OA, $ Millions	-	+90.0
Customer TOA	-	+90.0

SUMMARY OF EVALUATION: The decision document:

	FY 1996	FY 1997
• Establishes a program within the Services' DBOF Depot Maintenance and Supply Business Areas to finance investments in weapon system reliability (OA).	-	+90.0
• Increases O&M, Defense-Wide in FY 1997 to initially finance this program (TOA).	-	+90.0
• Provides for projected savings in the customer accounts in the outyears for these reliability enhancements: $-4.5 million in FY 2000, $-117.0 million in FY 2001, and approximately $-2.0 billion by FY 2010 (TOA).		
• Amortizes the cost of these investments on a straight line method, within customer rates in the outyears (TOA).	-	-
• Provides for the savings generated by this Depot Maintenance Reliability Program to be used for new procurement force modernization programs starting in FY 2000	-	-

DECISION THE DEPUTY SECDEF APPROVED THE ALTERNATE ESTIMATE

DATE JAN 29 1996

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DETAIL OF EVALUATION:

Reliability, Maintainability, and Supportability (RM&S) depot maintenance modifications to weapon systems can reduce their life cycle costs. Some studies have indicated that such investments can generate rates of return in excess of 9:1 over the life of the weapon system.. The Military Departments currently finance some aspects of these reliability improvements in their Defense Business Operations Fund (DBOF) programs. However, a more concentrated effort to identify and finance RM&S investments with high paybacks that are not currently being financed is justified because the longer-term results will be lower cost and more reliable weapon systems.

BUILD-IN RELIABILITY:

It has been recognized for many years that within the procurement process attention must be paid to the overall life cycle cost of a system, not just its initial purchase and deployment costs. Consequently, concerted efforts have been made to build-in increased reliability and maintainability in new systems and major end efforts and have institutionalized these concepts into new system procurements.

Further, under the Centers of Excellence approach within the Services' organic depots most major end items and weapon systems have assigned cognizant engineering support offices who provide a range of support for these systems. Support provided includes: assessing quality deficiencies reports provided by customers to identify components or aspects of systems that have high failure rates or require excessive maintenance, reviewing maintenance processes and methods to find more efficient and less costly means of maintaining systems, maintaining historical and engineered industrial standards on systems, and working with Weapon System Program Managers to identify both new technology that can be embedded in new systems and upgrades or modifications that can be procured and installed in existing systems to improve reliability.

However, the amount of funding targeted for reliability upgrades of existing weapon systems and major end items has been small, even though weapon systems are staying in the active inventory for longer periods and the number of new systems being procured has dropped significantly in recent years.

PROGRAM BUDGET DECISION No. 714

AVAILABLE TECHNOLOGY:

There are numerous examples of existing technology, available through current defense contractors, that have been demonstrated to improve the reliability or maintainability of numerous systems. Consequently, there is considerable potential for selecting proven technology for phased insertion into existing systems that are planned to be retained in the active inventory. These will either reduce failure rates of system components, increase the mean time between required depot maintenance on the system, or make the maintenance process itself more efficient and less costly. These investments will reduce the overall cost of ownership of these systems and improve battlefield performance by enhancing Mission Capable Rates.

DEPOT MAINTENANCE RELIABILITY PROGRAM:

The alternative establishes a program through the DBOF Depot Maintenance Business Area cognizant engineering support offices to finance selected technology insertion - modification projects to enhance the reliability of weapon systems and to reduce the cost of ownership.

Investments will be identified in a new, separate capital purchase category called RM&S Mods beginning in FY 1997. DFAS will establish a capability to separately track obligations and associated outlays by program year for these investments, as is currently required for equipment, minor construction, software, and non-ADPE DBOF capital purchase equipment investments.

Initial funding of $90 million will be provided in O&M, Defense-Wide, the Defense Logistics Agency, who will provide funded, reimbursable project orders to the Depots as listed in the table below. The project orders will include the acquisition cost of components or parts needed to be purchased and the costs associated with the installation of the item by the Depot after procurement, on a full funding basis for each approved project. DLA will, within the totals provided for each Military Department, fund the projects as provided in the final Component approved project lists, that have been authorized for inclusion in the respective DBOF Depot Business Area Capital budgets.

Outyear purchases will be financed, as with all the capital purchase program, using contract authority. Given the time required to set up the program, to establish guidelines, to identify technology projects, and to complete the acquisition process, no disbursements (cash outlays) in FY 1997 are anticipated. Modification kit deliveries and installations from FY 1997 investments are anticipated in FY 1999. Management of the program will be conducted through existing staff organizations within the depots.

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OUSD(A&T), in conjunction with OUSD(C), will develop and issue supplementary guide-lines and instructions for the Components on the related logistics and financial policy considerations for this program. The DUSD(Logistics) will identify procedures for identification of candidate technology insertion projects and distribute information on proven, high-payback modification programs. Additionally, the Military Departments will be required to provide present value, economic cost-benefit analysis studies to support requested projects, as required by the DBOF policies contained in the DoD Financial Management Regulation.

Current engineering staffs within each of the Service Depot Maintenance organizations are expected to locally manage the RM&S Mod program. The candidate Depot project lists must be prepared in conjunction with, and with the coordination of, the appropriate Weapon System Program Management offices in the Services. For FY 1997, the Components will provide the DUSD(Logistics) and the OUSD(C) a list of the specific projects that are proposed to be financed in FY 1997. Those projects meeting the general criteria established for the program and demonstrating an acceptable financial pay back will be approved for inclusion in the budget. The approved project lists and the appropriate DBOF budget justification exhibits are to be provided by the Services to the OUSD(C) and DLA by February 10, 1996, to provide sufficient time for the Components to include the projects in the individual DBOF Capital Purchase budgets that will be submitted to Congress in the President's budget.

Acquisition support for the Depot RM&S program will be provided by Inventory Control Points (ICPs). In FY 1997, after receipt of a funded order for the RM&S program the Depots will provide purchase orders to the appropriate ICP responsible for acquisition of any parts, components, or sub-systems required for the approved project. Depots will retain funding for the subsequent installation of the items. After FY 1997, Depots will continue to coordinate all proposed projects with cognizant Service Weapon System Program Offices and to acquire all required components, parts, or sub-systems through the appropriate ICP, in accordance with DBOF Capital Budget policies and procedures.

The Components' FY 1997 Procurement appropriation budgets should be adjusted to eliminate any current fully financed RM&S Mods that were to have been initiated in FY 1997. Components may propose realignment of any such projects into the DBOF RM&S Mods program. Approved realignments will be included in PBD 426.

Since the modifications purchased become a part of the weapon system or end item, which does not belong to the DBOF and cannot be depreciated, DBOF financing will be reimbursed by amortizing the cost of the investment within customer rates. The amortization will be on a straight-line 10-year basis consistent with other equipment investments within the DBOF.

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This customer surcharge will provide the necessary cash to finance these types of investments and to reimburse DBOF. The alternative provides for initial annual investments of $90 million. Further, the alternative provides for this program to be assessed again in the FY 1998 Program and Budget Review, to establish the future size and scope of this initiative in relation to other DoD and Component funding priorities.

Program savings, assumed to achieve an average 4.5:1 return on investment over 10 years, will more than offset cash requirements after the program becomes fully functional. The alternative provides for initial funding, additional capital purchase authority (OA), amortization, cash outlays, and projected savings as follows:

	(OA, $ in Millions) FY 1996	FY 1997
DBOF Business Area		
Department of the Army, Depot Maintenance Other	-	+24.8
Department of the Navy, Depots/Shipyards	-	+35.7
Department of the Air Force, Depot Maintenance	-	+29.5
Total	-	+90.0
O&M, Defense-Wide, DLA (TOA)	-	+90.0

AMORTIZATION TABLES
(Dollars in Millions)

(contributed to sinking fund through FY 01) AMORTIZATION

	FY98	FY99	FY00	FY01
Amortization				
90 in FY97	9	9	9	9
90 in FY98	-	9	9	9
90 in FY99	-	-	9	9
90 in FY00	-	-	-	9
90 in FY01	-	-	-	-
Total	9	18	27	36

	FY98	FY99	FY00	FY01
Cash Outlay				
90 in FY97	-	-	-	-
90 in FY98	-	45	45	-
90 in FY99	-	-	45	45
90 in FY00	-	-	-	45
90 in FY01	-	-	-	-
Total	-	45	90	90

PROGRAM BUDGET DECISION No. 714

	FY98	FY99	FY00	FY01
Savings *				
90 in FY97	-	-40.5	-81.0	-121.5
90 in FY98	-	-	-40.5	-81.0
90 in FY99	-	-	-	-40.5
90 in FY00	-	-	-	-
90 in FY01	-	-	-	-
Total	-	-40.5	-121.5	-243.0

* 4.5:1 over 10 years

	FY98	FY99	FY00	FY01
Cost (less approp.)	-	+45.0	+90.0	+90.0
Savings	-	-40.5	-121.5	-243.0
Amortization	+9	+18.0	+27.0	+36.0
Surcharge (funded by customers)	-	+22.5	-	-
Net Savings	+9	+22.5	-4.5	-117.0

As identified above, the investment is more than offset by the savings in the cost of ownership. These savings will be available to finance new procurement force modernization efforts after the annual savings begin to exceed the cumulative costs in FY 2000.

SUMMARY OF ADJUSTMENTS:

	(OA, $ in Millions) FY 1996	FY 1997
Alternative		
Department of the Army, Depot Maintenance Other	-	+24.8
Department of the Navy, Depots/Shipyards*	-	+35.7
Department of the Air Force, Depot Maintenance	-	+29.5
Total	-	+90.0

* OA in Department of the Navy to be distributed by business area based on final approved project lists.

O&M, Defense-Wide, DLA (TOA)		+90.0

OUTYEARS: (TOA, $ in Millions)

	FY98	FY99	FY00	FY01
O&M, Army	+2.5	+6.2	-1.2	-32.3
O&M, Navy	+3.2	+8.0	-1.6	-41.8
O&M, Marine Corps	+0.4	+0.9	-0.2	-4.7
O&M, Air Force	+2.9	+7.4	-1.5	-38.2
Total	+9.0	+22.5	-4.5	-117.0

29

DISPOSAL, RECYCLING, AND DEMILITARIZATION

"The significant problems we face cannot be solved at the same level of thinking we were at when we created them."

Albert Einstein

29.1 INTRODUCTION

The subject of this chapter is complex and evolving. It is an area in which the Program Manager (PM) and the Program Management Office (PMO) staff have obligations specified in various laws, executive orders, treaties, agreements, and a multitude of DoD and other agency regulations and administrative directives. This chapter is the briefest of overviews of DoD systems life-cycle planning in the areas of disposal, recycling, and demilitarization. The references offered at the end of the chapter should further expand the reader's abilities to meet PM responsibilities with reference to pollution-prevention activities.

29.2 STRUCTURE

In an effort to provide some structure to this subject, which broadly falls in the area of logistics, some text (abbreviated) and organization is taken from the *Materiel Developer's Guide for Pollution Prevention,* Army Acquisition Pollution Prevention Support Office, Second Edition, 1994, and used in the following text.

29.3 DEMILITARIZATION

DoD 5000.2-R, paragraph 1.4.6 (Demilitarization and Disposal), states: "At the end of its useful life, a system must be demilitarized and disposed. During demilitarization and disposal, the PM shall ensure materiel determined to require demilitarization is controlled and shall ensure disposal is carried out in a way that minimizes DoD's liability due to environmental, safety, security, and health issues." Paragraph 4.3.7 (Environment, Safety and Health) states, in part: "Environmental, safety, and health (ESH) analyses shall be conducted, as described below, to integrate ESH issues into the systems engineering process and to support development of the Programmatic ESH Evaluation...."

Decisions the PM makes during the acquisition process will influence the environmental impact of demilitarization procedures. As has been demonstrated by chemical munitions demilitarization programs, the environmental issues associated with demilitarization of a

system can be more significant than those created during all previous life-cycle phases. Effective planning during Phases I and II can minimize hazardous waste generation during demilitarization. As is the case throughout the life cycle, all demilitarization planning should reflect good business practices. PMs are encouraged to select a demilitarization approach that minimizes program costs while simultaneously creating as few adverse environmental impacts as possible.

The purpose of this discussion is to provide the PM with information about preferred demilitarization approaches that are also effective acquisition decisions. If an acquisition program is just being initiated, the PM will have many opportunities to plan for an environmentally acceptable system demilitarization. If a system is already fielded, demilitarization decision-making options may be limited. The overall concept associated with system demilitarization planning is that some disposal techniques are preferred because they create fewer environmental impacts than other processes. Figure 29-1 describes the hierarchy of preferred demilitarization techniques.

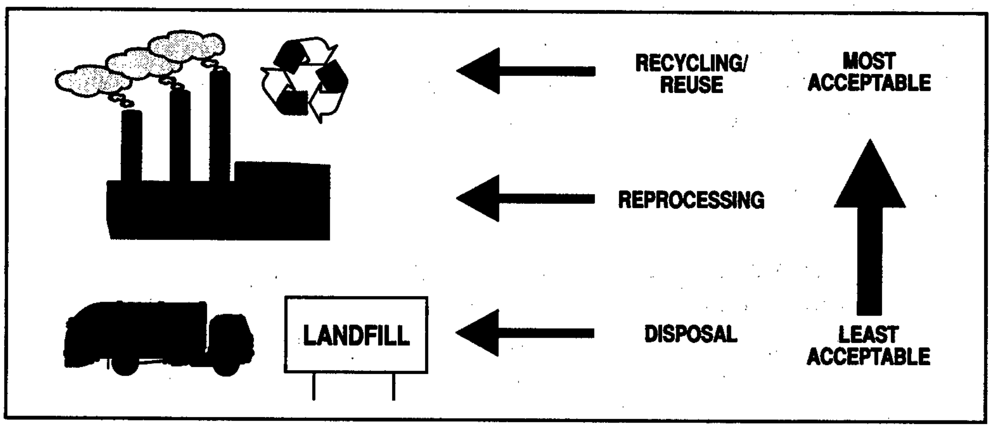

Figure 29-1: Demilitarization Approaches

29.3.1 Recycling

Recycling or complete reuse is the preferred system demilitarization process. Incorporating recycling into the demilitarization plan is simple, provided the system is amenable to disassembly. The decisions the PM makes regarding design features that will ease disassembly of the system into component parts of relatively uniform material composition will control whether or not recycling is a viable disposal process. For example, the automobile industry has developed a program that codes individual vehicle parts by types of material to allow recycling. Although adding design features that will ease recycling may increase production costs, overall system life-cycle costs could be lower because scrap vendors will, in many cases, pay the government for the separate materials.

29.3.2 Reprocessing

If a system is amenable to direct recycling, the next most preferred demilitarization method is reprocessing. Reprocessing involves the use of materiel in a manner different than that for which it was originally intended. Examples of reprocessing include the burning of explosives as fuels or the use of ground-up scrap tires in asphalt blends. In some cases, simple design or operational changes that can be made during the early phases of a system's life cycle can "make or break" a reprocessing program. For example, many Army activities currently reprocess petroleum products as fuels. However, there are severe limitations on the use of petroleum products that are contaminated with solvents as fuels. Thus, system maintenance processes should minimize the risk of mixing petroleum products with solvents to allow easy reprocessing. As was the case with the recycling example, any investments of this type, which can be made during the early acquisitions phases, have the potential for lower life-cycle costs.

Some PMs have found that proposing to reprocess materials can result in public concerns about the environment. As such, any reprocessing plan should describe specific procedures and include an environmental analysis. A specific Programmatic Environmental Analysis (PEA) should be completed before considering reprocessing as a demilitarization procedure. (See the reference in Section 29.2.)

29.3.3 Disposal in a Landfill

The final, and least preferred, demilitarization approach is for DoD to pay for disposal of a system in a landfill. Although the nature of a system may leave the PM with no other options, PMs should explore recycling and reuse before deciding to use any waste disposal procedure. Any disposal-based demilitarization plan must be accounted for in a life-cycle cost analysis. Life-cycle costs will be significantly higher for demilitarization plans based on disposal in a landfill than for those based on recycling or reprocessing. Again, a PEA is necessary before incorporating disposal into a demilitarization plan.

29.4 HELP AGENCIES

Numerous organizations are available within the DoD; the Federal government and state governments may be able to help a weapon system PM in planning for the demilitarization of a system. A single starting point is offered below:

Army Acquisition Pollution Prevention Support Office
ATTN: AMCRD-E/SARD-ZCS-E
5001 Eisenhower Avenue
Alexandria, VA 22333-0001; COMM: 703 274 5964; DSN: 284 5964

29.5 REFERENCES

The following list is a small sample of useful references:

1. *Materiel Developer's Guide For Pollution Prevention,* Second Edition, 1994.
   Source: Army Acquisition Pollution Prevention Support Office (See Sections 29.2/4 above.)
   Comment: This document is comprehensive and was written for the DoD weapon system PM with many references to other Federal offices and state agencies.

2. *Recycling and Reuse of Industrial Wastes,* 1995
   Source: Battelle Press, 505 King Avenue, Columbus, OH 43201
   Authors: Lawrence Smith, Jeffrey Means and Edwin Barth
   Telephone: 614-424-6393 or 1-800-451-3543
   Comment: This is an excellent document that addresses such subjects as propellant and explosive extraction and reuse, petroleum residues, and many others of interest to DoD.

3. *Navy Commanding Officer's Guide to Environmental Compliance,* 1991
   Source: Naval Energy and Environmental Support Activity under the Naval Facilities Engineer Command
   Comment: This is an excellent source; but some references, organizational material, and procedures may be dated.

4. *Acquisition Pollution Prevention AFMC Implementation Guide,* 1993
   Source: HQ AFMC/XRMP; DSN 787 5591
   Comment: This reference is Air Force oriented and may be dated.

5. *Pollution Prevention In Weapon System Acquisition,* 1994
   Source: AFMC, HSC/EM, 2909 North Street, Brooks AFB, TX 78235-5128
   Comment: This is an excellent resources. Volume One of a series of three volumes addresses the EMD Phase. Other volumes address other acquisition phases.

6. *Nuclear Waste Disposal Policy; Problems and Prospects for,* 1993
   Editors: Eric B. Herzik and Alvin H. Mushkatel
   Source: Greenwood Press, 88 Post Road West, Westport, CT 06881
   Comment: A well-written and scholarly work that is applicable to DoD.

7. *The Threat At Home, Confronting the Toxic Legacy of the U.S. Military,* 1992
   Author: Seth Shulman
   Source: Beacon Press, 25 Beacon Street, Boston, MA 02108-2892
   Comment: This interesting resource makes you aware of how those outside of the government view DoD.

8. *Congressional Oversight of the Fiscal Year 1995 Environmental Security Budget And Its Implications For The DoD Acquisition Process,* Thesis, 1995
Author: Robert A. Bean
Source: Naval Postgraduate School, Monterey, CA 93943-5000
Comment: This publication documents congressional dissatisfaction with the DoD environmental restoration policy (1995) while encouraging DoD to reduce environmental costs by improving or "greening" the acquisition process.

9. *Handbook of Solid Waste Management,* 1994
Editor: Frank Kreith
Source: McGraw-Hill, Inc., New York, NY
Comment: This handbook covers many subjects; some are applicable to DoD and provide engineering and cost detail.

10. Numerous DoD directives in the following series: 1000, 3100, 4100, 4200, 4700, 5000, 5100, 5200, and 6000.

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Defense Systems Management College
9820 Belvoir Road
Ste 3
Ft. Belvoir VA 22060-5565

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13. ABSTRACT *(Maximum 200 words)*

This guide is designed to provide logistics and acquisition managers with working familiarity of acquisition logistics. It addresses how to manage the acquisition logistics process throughout the life-cycle from preconcept exploration through post production support. The guide shows the inter-relationships of the major activities in the acquisition process of systems engineering, test, cost, risk, production, contracts, etc. It is designed to bridge the gap between general acquisition on logistics policy contained in DoD Directive 5000.1 and DoD Instruction 5000.2-R.

14. SUBJECT TERMS
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